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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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PUBLISHERS' ANNOUNCEMENT: REMOVAL OF THE OFFICES OF THE JOURNAL.

The proprietors of the JOURNAL herewith announce that the publishing offices are now located on the sixth floor of No. 42 Pine street, which building is just below the one occupied by the JOURNAL since 1891. The JOURNAL's new quarters (in reality they are old ones, for its publishing offices were maintained in the building that formerly covered the site of 42 Pine street from May, 1870, to May, 1891) are in a modern structure that is located in the heart of the financial business section of the city, and can be reached easily by or from any of the main lines of public travel. A. M. CALLENDER & Co.

[OFFICIAL NOTICE.]

Twenty-Fifth Annual Meeting, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
NEW ALBANY, IND., April 7th, 1902.

The Twenty-fifth Annual Meeting of the Western Gas Association will be held May 21st, 22d and 23d, 1902, in the New St. Charles Hotel, New Orleans, La., and will be called to order, at 10 A.M., by the President, Mr. Thos. D. Miller, of Dallas, Tex.

The Executive Committee has arranged for the presentation of the following papers:

"Experiments on Bench Fuel;" by Mr. W. A. Baehr, Denver, Col.

"Gasholder Specifications;" by Mr. H. A. Carpenter, Allegheny, Pa.

"Electrolysis;" by Mr. Jno. M. Humiston, Chicago, Ills.

"Beaumont Oil for Gas Making;" by Mr. Jno. H. Fitzgerald, Houston, Tex.

"Some Experiences in New Orleans;" by Mr. Bankson Taylor, New Orleans, La.

"Gas Engines;" by Mr. C. H. Nutting, Chicopee, Mass.

"Distributing Gas at High Pressure;" by Mr. Geo. F. Goodnow, Waukegan, Ills.

"Current Purifier Practice, and a New Form of Construction;" by Mr. F. H. Shelton, Philadelphia, Pa.

"Wrinkle Department;" edited by Mr. W. E. Steinwedell, Belleville, Ills.

A paper by Mr. B. E. Chollar, St. Louis, Mo.

The New St. Charles will be the Association headquarters. Rates for those attending will be as follows:

American plan: Two in room, $2.50 per day, each person; $3 per day one in a room. Rooms with bath, $3.50 per day and up.

European plan: Two in a room, $1 per day, each person; $1.50 per day and up, one in a room. Room with bath, accommodating two persons, $4.

Also, rates may be obtained from the Hotel Grunewald, Cosmopolitan and Denechand, as follows:

Grunewald: Strictly European, in connection with which there are two restaurants—Single rooms, $1 per day for each person occupying same. Room with bath, $2.50 per day.

Cosmopolitan: European plan, $1.50 per day and up.

Denechand: American plan, $2 to $3 per day; European plan, from $1 to $1.50 per day.

More satisfactory arrangements can be obtained by securing quarters in advance of meeting.

The New St. Charles Hotel Manager announces that they will have ample accommodations, except possibly that single rooms may be limited; but their double rooms will be satisfactory, as they are large and well located.

LIBRARY OF THE STATE OF [illegible]
APR 28 1902

Reduced railroad rates of one-and-one-third fare for the round trip, on the certificate plan, have been obtained for members, their wives and all persons attending the Western Gas Convention, through the courtesy of the representatives of the following Passenger Associations, conditional on 100 persons being in attendance: New England Passenger Association; Southeastern Passenger Association; Southwestern Passenger Association; Trunk Line Passenger Association; Central Passenger Association; Western Passenger Association.

The districts covered by railroads comprising the above Associations are all the States and territory east of Cheyenne, Wyo., including Texas, Utah and Colorado, and the New England States.

To obtain rates on the certificate plan to New Orleans, apply to agent at least 30 minutes before time for departure of train, purchase a ticket, obtaining from agent a certificate stating that full fare has been paid to New Orleans, which certificate will entitle purchaser to a one-third rate returning to starting point, providing said certificate is handed the Secretary for the purpose of indorsement by the representative of the Passenger Association, who will be present Thursday, May 22d.

Some Western roads furnish certificates from junction points only. Members are, therefore, requested to consult local agent as to the place from which certificates can be obtained.

Persons living outside the territory embraced by the above Passenger Associations will purchase ticket to most convenient point within territory from which rates are applicable, and from there purchase ticket on the certificate plan to New Orleans.

Tickets as above can be purchased from and after May 17th, and are good returning, leaving New Orleans not later than May 27th.

Gas companies are solicited to send representatives to become members of the Association. The membership fee is $10, annual dues thereafter, $5. The Association publishes in bound volumes proceedings of its meetings. Copies when published are furnished free to members.

Queries for the Question Box, if mailed to the Secretary in advance of the meeting, will be assigned to members for answer.

Any information regarding the meeting will be gladly given by the undersigned. JAMES W. DUNBAR, Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF WRINKLE DEPARTMENT.
BELLEVILLE, ILLS., February 12th, 1902.

This department is now open and ready for contributions, which will be presented at the Twenty-fifth Annual Meeting to be held next May. The active co-operation of all members and friends is earnestly solicited. Please forward contributions to the Editor before April 15th.

W. E. STEINWEDELL, Editor.

BRIEFLY TOLD.

THE FOURTH ANNUAL MEETING OF THE SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION.—"It is usually regarded that Friday is not a good day on which to begin anything; but if on such account anyone had misgivings about the success of the Southwestern's Fourth Annual Meeting, those doubts were completely dissipated when President H. F. MacGregor called the meeting to order, the morning of Friday, April 18th, in the appointed headquarters at San Antonio, Texas. The weather was ideal, and our First Vice-President, the only "Ed." H. Jenkins, was the heartiest sort of a host. In fact everybody in San Antonio acted as hosts of the right kind. The services of the street railway were tendered gratuitously to all attending the meeting. After the usual address of welcome, spoken by Mayor Hicks, and blandly responded to by one who knows how to say such things, the business of the meeting was taken up and expedited without being slighted. The work of the Association was, as might have been expected, electrically technical. The discussions naturally ran to those things which give the most trouble, and while technical subjects held the boards a large part of the time, matters of business and public policy received quite a share of attention. The paper by Mr. E. H. Jenkins, on "Progress Clubs in Texas," is in the right direction, and details a species of work that can be well handled by State and district Associations. President MacGregor's address was well received. Papers that were of especial interest to gas men were: "Fuel Oil," by Mr. W. W. Reed, of Houston, Tex.; "Flat Rate Evil," by Mr. Thos. D. Miller, of Dallas, Tex.; and "How to Increase Your Business," by Mr. A. E. Judge, of Tyler, Tex. Fully 100 were in attendance, and the Association was honored by the presence of a goodly contingent of the fair sex. The trolley ride on Friday afternoon, which was ended in a fine repast at the Hot Sulphur Hotel, was greatly enjoyed. The ceremony of the rejuvenation of the Sons of Jove was lurid and long to be remembered. In fact, the meeting was especially remarkable for the number and success of the various entertainments provided. The officers elected were: President, E. H. Jenkins, San Antonio, Tex.; First Vice-President, C. F. Yeager, Laredo, Tex.; Second Vice-President, R. E. Dysterud, Monterey, Mex.; Third Vice-President, A. E. Judge, Tyler, Tex.; Secretary, T. H. Stuart, Waco, Tex. The meeting was a good one in every sense.—D."

[CONTINUED FROM PAGE 575.]

PROCEEDINGS, EIGHTEENTH ANNUAL MEETING, OHIO GAS LIGHT ASSOCIATION.

HELD IN COLUMBUS, O., MARCH 19 AND 20, 1902.

SECOND DAY, MARCH 20, AFTERNOON SESSION.

The Association met, pursuant to adjournment, at 10 A.M., March 20. The President announced that the first business in order was the discussion of the topic

DISTRIBUTION OF GAS UNDER HIGH PRESSURE.

Mr. F. H. Shelton, of Philadelphia, Pa., had prepared a written contribution on the subject. In the absence of the author the contribution was read by Mr. George H. Tayler, as follows:

To the Members of the Ohio Gas Light Association—Gentlemen: Your President has requested from me, as a "short topic" for discussion at this meeting, a statement as to the conditions under which delivering gas at a number of pounds pressure becomes useful, in the way that I inaugurated some 2 years ago, and with which practice I have recently been rather associated. I am glad to briefly give you the results of some 2 years' operations and conclusions.

The essence of high pressure work (and by that I mean starting the gas out at 10, 20 or 30 pounds pressure) is that by such means pipes of but ¼ or ⅛ the usual size can be used, and hence construction cost greatly reduced. Four kinds of situations come to mind in which this way of working enables saving in running expense, or improvement in service, or the extension of gas supplies to places that otherwise would have to go without.

1. *The Supply of Adjoining Works.*—At Phœnixville, Pa., the first line was started December, 1899, running 5½ miles, 3-inch pipe to Royersford and Spring City, enabling the closing down of those works, and making all the gas at Phœnixville.

At Rockaway Beach, New York, a similar line, 6 miles long, 4-inch size, has enabled the supply and the closing down of the old Far Rockaway works.

At Hackensack, N. J., a 6-mile line, 5-inch size, has enabled the closing down of the Rutherford (N. J.) works.

8. *The Re-Inforcement of Supply to Existing Mains Overtaxed.*—New Orleans has over 200 miles of mains. Heavy gas fuel business has overloaded them. An 8-mile independent system of new 6-inch and 4-inch pipe, leading to 5 points in the city, where it ties into the old mains, is now finishing. By these pipes, and a gas pump at the works, 50,000 to 75,000 feet of gas per hour is switched to the districts where it is needed, at a cost of some $45,000 for the equipment, where 24-inch and 16-inch boosting mains otherwise laid in the old way, would have cost $100,000 or more.

3. *Extension of Gas Supply to Nearby Points.*—If $40,000 or $50,000 is required to build separate plants to supply gas in sundry small towns, many will go without: but if $15,000 to $20,000 will get gas there, by high pressure, from the nearest gas works, many such towns get gas service that otherwise would not. For example:

The River Shore Gas Company, Riverton, N. J., by a 3-inch line, 4 miles long, to Moorestown, and a 3-inch line 2½ miles long to Riverside, supplies gas by high pressure, for little cost, from its plant at Riverton, to these places of 3,500 and 2,500 population, that otherwise would not get it.

The North Shore Gas Company supplies gas from its works at Waukegan, Ills., through a high pressure pipe, 4-inch size, 12 miles long, to the neighboring points of Lake Forest, Fort Sheridan, Highland Park, etc., that would otherwise have waited a long time, if a 20-inch main had had to be laid.

Several other examples of this condition exist, where high pressure has opened up districts otherwise not ripe.

4. *Supply of a Thin or Scattered Territory.*—The Philadelphia Suburban Gas Company, with its works at Darby, and first business through 25 miles of low pressure main, to a fairly compact district, supplies also, however, an additional population of 10,000 or more, in a dozen or more villages and boroughs scattered over a territory 8 miles long and 3 wide, to which it would not have paid to run for 5 years the 16-inch and 12-inch pipes, otherwise necessary on usual lines. High pressure has developed this territory. The largest main is 6-inch; 1¼-inch pipes supply many streets. There are altogether some 25 miles in this high pressure system, directly supplying 1,000 or 1,200 customers, at from 5 to 15 pounds pressure, with individual pressure regulator in each house. A couple of $600 pumps keep up the supply perfectly well. No holders are used.

The above instances clearly show the use and application of high pressure gas distribution. It is entirely and practically successful. I think each of these dozen places now using it are fully satisfied with the results. One is in its third year. Several are in the second year.

It is no longer a question of experiment, but simply one of cost. A given business exists. A 3, 4, or 6-inch high pressure main will reach it from the works. This main will cost so much. A pumping plant will cost $700 to $2,000. The pressure regulators will cost a few hundred dollars. Allow, say, 2 cents a 1,000 for the running expenses of pumping the gas, and you can easily figure whether it is worth while or not.

No holders are needed at the far end. We have not used such for two years at Phœnixville, nor ever at Darby, nor have half the other places using high pressure. Condensation, and break downs and loss of candle power, and also the other bugaboos that were thrown at me when I first started this plan of working, will not trouble you. The equipment works just as well as the rest of gas works machinery. High pressure has come, and come to stay. More plants are going in. It is extremely helpful in many circumstances, and to those of you who want to boost low pressure at little cost, or want to consolidate with a nearby works, or want to get gas to a small place nearby, or in other words want to push gas cheaply from the place where it is made to another place where it is wanted, I say to you high pressure is well worth carefully considering.

My ideas more in detail, you can find in three papers already read by me. The first, at the Western meeting in Milwaukee, "Distributing Gas Under High Pressure," in June, 1899, gives the logic and theory of it. The second, before the New England Assoctation of Gas Engineers, February, 1900, "Pumping Gas Five Miles at 20 Pounds Pressure," describes the first, or Phœnixville line.

The third, "The Reduction of the Cost of Distribution by the Use of High Pressure," a paper before the International Gas Congress, Paris, France, September, 1900, goes more fully into the subject, the details of equipment, etc.

But accept this word of caution. Do not string a pump, a line of pipe, and a regulator only together, and expect satisfaction. There are a score of details necessary for satisfactory results. If the work is badly planned and executed, it will be a source of danger, expense and dissatisfaction. But with the details and small parts properly planned and carried out, gas can be handled safely at 20 pounds pressure, economically and with great satisfaction.

Discussion.

The President—In the discussion of this subject we hoped to have two in favor of and two against, but three of our expected contributors disappointed us. We will have to look for an impromptu discussion on the floor. Has anybody anything to add to what Mr. Shelton has said about the distribution of gas at high pressure? Mr. Miller, what have you to say about it? Are you a high pressure man?

Mr. Miller—I do not know that I can add anything, Mr. President, regarding the distribution of gas at high pressure.

The President—Did you ever make any figures on it?

Mr. Miller—I do not think there is yet any necessity for going into anything of that kind.

Mr. Littlehales—I think it is clearly evident to us all that Mr. Shelton, in the experiments he has made and in the undertaking he has carried out, has conferred a very great and lasting benefit on the gas interests, by demonstrating in the practical way he has that what seemed at first to be such a radical departure, has, with experience, proved to be so thoroughly successful. I am a thorough believer myself in the practicability of the method, and it can be applied very advantageously, I am sure, in a great many places, by many gas companies supplying outlying districts.

The President—Mr. Littlehales, don't you have to disregard Pole's formula to believe there is anything much in, or to have any great faith in high pressure distribution?

Mr. Littlehales—I cannot see how that formula affects it.

The President—Pole's formula is that as you quadruple the pressure you double the delivery, and the formula also assumes that as you increase the diameter you increase the conductivity about as the 2½ power.

Mr. Littlehales—Yes, that is correct.

The President—Then that means that by increasing the diameter of a pipe 4 times you would increase its conductivity about 32 times, and increasing the conductivity of the same size pipe by additional pressure would require 1,024 times the initial pressure.

Mr. Littlehales—Not necessarily, because as you increase the diameter you lessen the friction proportionately, and consequently, for example, with the same capacity in one 4-inch and in 4 two-inch pipes the one 4 inch would deliver a good deal more gas than the 4 twos.

The President—One 4-inch would deliver about 50 per cent. more gas than 4 twos?

Mr. Littlehales—Yes, because there is much less friction.

The President—No, the conductivity should be about as 3 is to 2.

Mr. Littlehales—The friction on the surface would be about as 12 is to 24.

The President—The reason the gas does not increase as the area of your pipe is because your area increases faster than your frictional walls increase.

Mr. Littlehales—Yes.

The President—It would increase as the square of the diameter, if the walls increase as rapidly as the area, but the area increases more rapidly than the walls, therefore, it is supposed to be about as the square root of the fifth power, which would be about the 2½ power. If you assume that the conductivity of a 1-inch pipe is unity, a 2-inch pipe would have a conductivity of about 5½, a 3-inch pipe would have a conductivity of about 16, and a 4-inch pipe would have a conductivity of about 32. You have to quadruple your pressure to double your flow, and to increase your flow equivalent to an increase in diameter of 4 times, it makes an increase of pressure necessary of about 1,024 times.

Mr. Littlehales—I have been figuring this out myself in several places, and find that it can be practically and advantageously applied in a number of cases where I have had occasion to figure on the same basis. It has been said that it is futile to attempt to accomplish things which are impossible, but this has been done. Now if a thing has been done for 3 years all the theories on earth can not alter that fact. It is fact *versus* theory. The question which has always worried me is the loss of illuminating power or the possible loss due to condensation, because I know in compressing Pintsch gas a great deal of hydrocarbon originally formed in the gas is squeezed out of it by compression, yet it seems that there is no perceptible difference that the trained eye can discover. Doubtless there may be some difference which a careful photometric test on a bar photometer would reveal; but the gas man, whose eye is pretty well trained in judging of the intensity of lights, has been unable to discover any perceptible variation.

Mr. Dunbar—You indicated in your address yesterday, if I mistake not, Mr. President, that you were not in accord with the efficiency of distributing gas under high pressure. Am I correct?

The President—You are correct to this extent: I qualified that by saying "Very high pressure." We have had underground installations running up to about 20 inches for a good many years, and up to that point I consider it thoroughly practicable.

Mr. Dunbar—Up to 20 inches?

The President—Yes, sir; I think the conditions are very few where you are warranted in going above 5 pounds.

Mr. Dunbar—I wish you would give us your reasons for opposing the distribution of gas at very high pressure, and in doing so I would like you to give us the benefit of your ideas as to the relative efficiency of a compressor or exhauster—a rotary exhauster working, say, at 5 pounds pressure.

The President vacated the Chair in favor of Vice-President Andrews, and the former said: In 1848, I think, Pole's formula was announced to the gas fraternity, and it has heen in universal use ever since, except for computing the flow of natural gas. The factors in that formula are the pressure, distance and diameter of the pipe. From numerous experiments made in this country and in England, gas men have never had occasion to believe that Pole's formula was far from correct. They believe that the flow of gas increases as the square root of the fifth power of the diameter, or about as the 2½ power. They also had no reason to believe that the law that the flow of gas is as the square root of the pressure was incorrect, or, if you want to reverse that law, to say that the resistance would be as the square of the gas flowing. Now, say a 1-inch pipe has a conductivity of 1; if Pole's formula is right, then a 2-inch pipe has a conductivity of about 5½ times that much, a 3-inch pipe that of about 16 times, and a 4-inch pipe a conductivity of about 3-times that of a 1-inch pipe. If on a 1-inch pipe you are running at an ounce pressure, it would be equivalent to about 17-tenths; to increase your flow 5.57 times you have to increase your pressure to about between 25 and 30 ounces, to make a 1-inch pipe equivalent to a 2-inch pipe by pressure. To make a 1-inch pipe equivalent to a 3-inch pipe by pressure would require a pressure which would be the square of about 16, or in the neighborhood of 250 ounces. To make it equivalent to a 4-inch pipe you would have to take the square of 32, and it seems to me it would be something over 1,000 ounces to make a 1-inch pipe equal to a 4-inch pipe in conductivity. Mr. Shelton has gone into the use of

higher pressure and is getting practical results from it. I have never seen any fine-haired tests on the results he was getting, nor have I ever seen any accurate measurements to tell whether his candle power has depreciated or not. I believe it will be depreciated not only by compression but by the velocity of the flow, which induces all the evil effects of impact and gives us the very process we use for taking tar out and the heavier vapors in our manufacturing plants. I do not know that the flow has been increased in any faster ratio than held by or shown in Pole's formula. I have never seen any figures that disproved Pole's formula, and it seems to me the pressure required is so enormous that, if you are going to have any great volume of delivery, you can better afford to put in a larger pipe and seek to reasonably lower the pressure. Another consideration is the great loss resulting from the compression of air or gas. The efficiency of the air transmission plant in Michigan is about 30 per cent., the transmission with mechanical deficiency is 10 per cent., and the other 60 per cent. is thermal loss. As soon as you start to run up the pressure of a gas you are dissipating more or less heat. The reason I asked for a contribution on this subject was with the hope of getting about a half dozen of gas engineers here so that they could whip this whole thing out and let the members of this Association see how far they were warranted in using high pressure, and what were its limitations. I find an impression in the gas fraternity that high pressure has no limitations. I know that it has some. I know also that high pressure has certain applications where they can advantageously be made. If I am not digressing too much I want to say a word about this programme method. We were unable to make the people fully understand what we wanted this time, but if we could have the Association once indorse it, and after the members here fully understand it, I believe this method we have adopted will be more instructive and beneficial to us than any other scheme heretofore brought out in any of our Associations. It aims to get the opinions of all men who have opposite views, and it means that the gas men of the country will either be in a quarrel on the subject or will thresh it out and have it settled, or it means, where there is something to be said on both sides, that the gas men who hear the subject discussed will know just how much can be said on the matter and how much merit there is to each side of the question.

Mr. Littlehales—I would like to supplement my previous remarks by stating that I had more particularly in mind the delivery of gas at long distances, rather than distributing under high pressure, as would be the case in carrying it from central points to surrounding towns or villages. That is my highest appreciation of it rather than the distributing under high pressure at short distances, because I know it is available for long distances, and that is the point wherein I appreciate its great value.

The Vice-President—Mr. Shattuck, we would be glad to hear from you on this matter, inasmuch as you are familiar with what is being done at Darby.

Mr. Shattuck—Most of the features of our plant have been covered very thoroughly in papers written by Mr. Shelton, so that you probably all know of the work doing there. We are supplying gas under high pressure locally to every consumer; we have a low pressure system through 5 towns and a high pressure system through 7, and we are about to consolidate the 2 plants and shut down one of them, connecting our low pressure direct with the high pressure, so that the entire system outside of one large city will be of the high pressure type. I do not think we would recommend for a minute taking up low pressure mains and putting high pressure in place of them, but for suburban territory, where we could not borrow the money to put in a low pressure system, the best thing we could do was to put in a high pressure system in our case. We are getting a nice return for the money invested, and it is the character of country which I doubt will ever be thickly populated enough to warrant taking up the high pressure system and installing a low pressure system. It is largely residential, and I think it is the ideal system for that territory. For instance, we are running a line of 1¼-inch pipe on which we have 25 to 40 consumers per mile. We can do a nice business on the investment by the high pressure system, whereas with a low pressure system we would want much more than that. We are experimenting in pumping gas by putting in more economical engines, using duplex compressors and cutting the steam consumption anywhere from 70 to 80 pounds per horse power down to less than 30, and by compounding we can do even better than that, cutting it down perhaps to 20 pounds. That makes the pumping per 1,000 feet very cheap.

Mr. Doherty—How cheap?

Mr. Shattuck—Less than one cent; just how much cheaper than that I cannot state without further experiments, but we will be in shape before long to tell very accurately just what it costs to pump gas at high pressure. The candle power does not seem to be affected by compression; that is, commercially. It was tested with an ordinary jet photometer—we have the high and the low pressure gas rigged to the same jet photometer, and the former gas shows about 1-candle power more than the latter. The reason of that I suppose is because of the condensation from compression, which seems to change its specific gravity, dropping out the moisture and making it lighter; but commercially you may say that there is no loss in candle power.

The Vice-President—We will be glad to hear from others who have ideas on the subject of the difference in transmission in the pipe, as well as upon the main point at issue. I would ask Mr. Wile if he desires to add anything to this discussion.

Mr. Wile—Nothing, except that by compressing you gain in volume while the friction does not increase with the amount of compression. That is, the gas after it is compressed possibly amounts to twice the volume, while the friction does not increase.

Mr. Doherty—The friction does increase, if Pole's formula is right.

Mr. Littlehales—The frictional surface does not increase.

Mr. H. A. Carpenter—Has anything been said about the amount of gas that any one of these small lines is delivering under a given pressure? The velocity of flow is the troublesome point I should think, and I have not seen any figures given in any of these papers touching on that point.

Mr. Shattuck—In the crude experiments we have made we find we are getting about 25 per cent. more delivery than the theoretical formula, as far as we have been able to ascertain. I made an attempt only recently, after measuring the actual discharge of a 1¼ inch pipe through 2,400 feet, and with the consumer burning 10 feet per minute through the stated service and main we found that the pressure in the line fell so slowly that practically the record was not of much value. For instance, we were not pumping at the time, and the pressure on the main line was 18 pounds, and at the end of this service it stood at 18¼, so that the pressure was going down very slowly on the main line but falling less siowly on the service from which they were burning the 10 feet a minute; but, as I said before, we find about 25 feet per cent. more delivery from the crude experiments we have made than that shown by the theoretical formula.

Mr. Doherty—In other words, Mr. Shattuck finds that the flow of the gas is as the square root of the pressure—that that law is not accurate for high pressure.

Mr. Shattuck—Not accurate for high pressure gas.

Mr. Doherty—How do you explain that fact?

Mr. Shattuck—I am at a loss to explain it. Whether that law is working out specific gravity I cannot say. It is an air law I think. I do not think it is true for all gases at high pressure.

Mr. Doherty—The law that the flow of gas is as the square root of the pressure, and taking the drop of pressure through the pipe as the pressure factor, I know is not strictly correct. The flow is greater than that. Now I never wanted to appear as trying to help the advocates of high pressure out in the way of explanations for the upsetting of our old formulas and laws. I know that Pole's formula does not apply to high pressure, and I cannot see but that all energy put into the gas in compressing it results in adding that much to its conductivity. There is nothing else to come from pressure, because you pick up the necessary temperature in the ground, and it virtually stays at a constant temperature, and that energy is stored up in the gas, and as it must dissipate itself some place it dissipates itself in increased conductivity. That is a nice little problem in calculus that I do not care to tackle; but still I do not think there is a great deal in high pressure systems.

The Vice-President—Mr. Moses can possibly give us some information, for I understand he is about to put in a high pressure line in New Jersey.

Mr. Moses—We are making preparation to put in about 39 or 40 miles of high pressure pipe, and will start on it in about two weeks.

The Vice-President—How high?

Mr. Moses—It will run from 20 to 30 pounds. We expect to deliver 150,000 feet an hour at 38 miles distance, through a 12-inch pipe.

Mr. Dunbar—I asked as to the relative efficiency of compressors or exhausters working, say, at 5 or 10 pounds pressure. Will some one please give me information on that subject.

Mr. Doherty—I forgot the question which Mr. Dunbar asked. I cannot give an opinion on that that would be as accurate as the opinion which Mr. Johnson may probably give you.

The Vice-President—We would be very glad to hear from Mr. Johnson on the subject.

Mr. E. D. Johnson—I can say, Mr. President, that no very accurate

tests have been made between compressors and high pressure exhausters, but from the practical results attained by those who are using them I will say that they prefer the exhauster, on account of the first cost largely. In one instance I remember (the test was made with air and not with gas) the efficiency of the exhauster, from 3 to 7½ pounds, was a higher mechanical efficiency as well as volumetric, than the air compressor. Beyond 7½ pounds I think the ordinary compressor will have the advantage, but below that, with water backing for the rotary machine, we get a higher efficiency than with the air compressor, and with air I presume it would be the same as with gas.

Mr. Shattuck—An ideal compressor to my mind is one that has mechanically actuated inlet valves measuring full cylinder at each stroke. These valves are operated practically like the Corliss valves. We have an engine of that kind at present, and the slip in the machine must be very little indeed.

Mr. Carpenter—I think it might be a good plan for this Association, perhaps, to appoint some one of the gas companies, or engineers of gas companies interested in this subject, to make experiments on the delivery of artificial gas through various lengths of different sized pipes at varying pressures, so as to settle this question. If Pole's formula is wrong, and no one can come forward to substitute one that is correct, why I should think it would be to our advantage to settle this matter by experiment as soon as convenient.

Mr. Doherty—I think it would be rather a hard thing for this Association to get anybody to take up an experiment of that sort. I have thought about it and I have given it a good deal of consideration. It cannot be done without a great deal of work and a good deal of expense, but what I think the Association could do would be to appoint a committee to prescribe how such a test might be made—that is the stumbling block; get some accurate data. I simply suggest this to Mr. Carpenter and then he can formulate his motion accordingly. I would suggest that he word it so it would authorize the appointment of a committee to prescribe methods for determining the law governing the flow of gases at all pressures, then any gas company can take it up very easily.

Mr. Carpenter—I did not intend to make a motion, but simply a suggestion.

Mr. J. O. Johnston—Perhaps, if you are about to appoint a committee, I might suggest how they could obtain some information at least. Natural gas companies have had a large experience in piping gas under varying pressures, and from such experience are fully convinced that the formulas from which tables are constructed are not accurate. In my opinion accurate figures can only be arrived at when the changed conditions of velocity and friction are taken into consideration. I believe that the engineers of natural gas companies controlled by the Standard Oil Company have made some thorough tests in this direction, and undoubtedly valuable information could be secured from them. My own experience in the measurement of gas under varying pressures has been by the use of the Pitot gauge, together with the formulas and tables prepared by Professor Robinson, which under moderate pressures are fairly accurate, as shown by the meter measurement of the same gas. However, I find that where there is an increase of pressure there is an increase in the meter measurement of the gas over and above the amount shown as measured by the Pitot gauge. I believe the reason for this discrepancy is due to the fact that existing formulas do not take into consideration the changed conditions of friction and velocity. My idea is that by an increase of pressure you have a much greater increase of velocity in the center of the pipe without a corresponding increase of resistance, and that if accurate data could be secured it would be found that from 5 to 50 per cent. more gas would pass through a line with increased pressures than the amount figured from existing formulas and tables.

The Vice President—I am sure the opinion Mr. Johnson has just given us is very valuable, as indicating what is being done along similar lines in natural gas work, and if Mr. Carpenter will make a motion covering the point brought up a few moments ago, I shall be glad to put it to the Association.

Mr. Carpenter—I move that the President appoint a committee to investigate the subject of the law governing the flow of artificial gas at high pressure or at pressures above the ordinary.

Mr. Littlehales—In seconding the motion, I presume it includes the President's suggestion of ascertaining the best practical mode of carrying it out?

Mr. Carpenter—Of course my motion is intended to comprehend the appointment of a committee to cover the subject as fully as it can, in whatever direction seems advisable, and to report at some future time. [The motion was unanimously adopted.]

The President, on resuming the chair, named the following as the members to comprise the committee under Mr. Carpenter's resolution: H. A. Carpenter, Pittsburg, Pa., J. O. Johnston, Columbus, O., J. D. Shattuck, Darby, Pa.

The President further requested that the committee, if it could not determine by experiment the disputed points, would report as soon as possible on the best method of making such a test, so that any one without the technical knowledge could undertake the test, if desired.

The President announced that the next topic for discussion was

RECENT DEVELOPMENTS IN BY-PRODUCT COKE OVENS,

communications on which had been received from Dr. F. Schniewind, of New York, Mr. Thomas Littlehales, of Syracuse, N. Y., and Mr. C. W. Andrews, of Hamilton, O. Dr. Schniewind read as follows:

The coke oven has, of late, attracted the serious attention of the gas engineer. "Coke oven gas" has been recovered in by-product coke ovens for many years, especially on the European Continent. The United States and England were slow in changing from the beehive oven to the modern type, but recently the introduction of by-product coke ovens into the United States has made very satisfactory progress. There are in all, in operation and in course of construction in the United States, about 3,000 by-product coke ovens. By far the larger number of these plants has been built by, or according to plans furnished by The United Coke and Gas Company. The list of ovens in operation and in course of construction is as follows:

By-Product Coke Ovens in Course of Construction, by the United Coke and Gas Company.

No.	Owner.	Location.	Erected in	No. of Ovens.	Coke Used for	Gas Used for
1	Cambria Steel Co.	Johnstown, Pa.	1895-98	160	Blast furnace.	Fuel.
2	Pittsburg Gas and Coke Co.	Glassport, Pa.	1896	120	Blast furnace and domestic.	"
3	New England Gas and Coke Co.	Everett, Mass.	1898	400	Domestic and locomotives.	Illuminating.
4	Dominion Iron and Steel Co.	Sydney, C. B.	1900	400	Blast furnace.	Fuel.
5	Hamilton Otto Coke Co.	Hamilton, O.	1900	50	Foundry and domestic.	Illuminating.
6	Lackawanna Iron and Steel Co.	Lebanon, Pa.	1901-02	232	Blast furnace.	Fuel.
7	" " " "	Buffalo, N. Y.	1901-02	564	Blast furnace.	"
8	South Jersey Gas, Electric and Traction Co.	Camden, N. J.	1901-02	100	Foundry and domestic.	Illuminating.
9	Maryland Steel Co.	Sparrow's Point, Md.	1901-02	200	Blast furnace.	Illuminating and fuel.
10	Michigan Alkali Co.	Wyandotte, Mich.	1901-02	15	Burning lime.	Fuel.
11	Sharon Coke Co.	Sharon, Pa.	1901-02	212	Blast furnace.	"
			Total.	2,453		

The later plants have a daily charging capacity of 8 net tons of coal per oven per day, while the earlier plants vary between 5 and 6 net tons. The entire charging capacity of all these plants is about 14,350 net tons of coal per day.

It is unnecessary to give a detailed description of the process here, which may be found in a paper recently read before the International Engineering Congress at Glasgow. In order to give an idea of the construction of the ovens, a large picture of the Camden (N. J.) plant, now in the course of construction, may be referred to, which is exhibited here. It shows the detailed construction of the ovens proper. Another picture of our new type of ovens, as described in the Glasgow paper, is being prepared. The United Coke and Gas Company will be glad to furnish copies of these pictures, as well as the copies of the paper referred to above. The plant at Hamilton, O., is very similar to the Camden plant; the only exception is that the coke wharf has an angle of about 33°, while the coke wharf of the Camden plant is almost level.

It is the desire to discuss the subject especially from a point of view

which will interest the members of the Ohio Gas Light Association, and consequently the process will be described only in a general way.

Process.—The retort coke oven process in its principles is closely allied to the coal gas retort process. Instead of charging, however, into the retort only a few hundred pounds of high grade gas coal, the retort coke oven receives a charge of 16,000 pounds of coking slack coal. If no slack coal is available, the coal is crushed before charging it into the retorts.

Products.—On average coking coals the following yields are obtained: 75 per cent. coke, of which for instance at Hamilton, O., 90 per cent. to 95 per cent. is foundry grade; 5 per cent. to 6 per cent. tar; 1 per cent. to 1.25 per cent. sulphate of ammonia, which is shipped either in the form of sulphate, or in the form of concentrated liquor; and 4,000 to 5,000 cubic feet of surplus gas per net ton, of 18 to 20-candle power, and approximately 700 B.H.U. per cubic foot.

The old-fashioned gas retorts are heated by a part of the coke, while the by-product coke oven is heated by a part of the gas. The coke oven gas has only become important for illuminating purposes since it has been fractionally separated. It has been shown that the gas driven off in the earlier part of the coking process, while the temperature of the coal charge is still low, is of a very much higher illuminating and fuel value than the later product. In our modern ovens the second or poorer fraction is burned under the ovens in order to produce the heat necessary for the coking process, while the first or richer fraction is distributed as an illuminating gas.

Coke.—The coke can be used either for metallurgical purposes (blast furnaces, foundries, etc.), or for boiler firing, domestic purposes, etc.

Metallurgical Coke.—The consumption of metallurgical coke in Ohio is very large; it is second only to that of Pennsylvania. No accurate statistics are available for the amount of coke used by foundries and for miscellaneous metallurgical purposes. The production of the Ohio blast furnaces, according to latest statistics, is as follows:

Production of Pig Iron in Ohio in 1901 *by Districts, in Tons.*

Mahoning Valley	1,404,857
Hocking Valley	35,000
Lake Counties	783,490
Hanging Rock	299,301
Miscellaneous	793,710
Total	3,316,358

Each gross ton of pig iron requires nearly 1 net ton of coke. This tremendous amount of 3,300,000 net tons of coke has been entirely made in beehive ovens, with the exception of the comparatively insignificant output of the 50 Otto-Hoffman ovens at Hamilton, O.

The production of 1 net ton coke in beehive ovens requires 1½ net tons of average coking coal, but in by-product ovens only 1⅛ net tons are required. The coal consumption for the production of the above 3,300,000 net tons beehive coke has, therefore, been 4,950,000 net tons, while in by-product ovens it would have been only 4,400,000 net tons—a waste on coal account alone of 550,000 net tons.

As stated above, average coking coals yield in our by-product coke ovens at least 5 per cent. tar, 1 per cent. sulphate of ammonia, and per net ton of coal at least 4,000 cubic feet of surplus gas. If the 3,300,000 net tons of coke would be produced in by-product ovens, the following enormous quantities of gas, tar and ammonia could be saved every year: 220,000 net tons—880,000 barrels, tar; 44,000 net tons sulphate of ammonia; 17,600,000,000 cubic feet illuminating gas. In addition to this, as stated above, 550,000 net tons of coal less would have been consumed. It is not probable that such outrageous waste is likely to continue.

Almost the entire blast furnace coke (3,300,000 net tons) and in addition to this several hundred thousand tons of foundry coke, have been brought into Ohio from other States, chiefly from the Connellsville district, Pa. The Ohio production of coke has been less than 100,000 net tons per year, which figure has recently been slightly increased by the product of the 50 Otto-Hoffman ovens at Hamilton.

Since the introduction of by-product coke ovens, other coal fields outside of the Connellsville district have been made available for the manufacture of metallurgical coke. These coals did not produce in beehive ovens a coke suitable for blast at the mines to the blast furnaces and convert it there into coke in by-product ovens instead of coking the coal in beehive ovens at the coal mines, and shipping it long distances to the furnaces. The freight on a ton of coke is higher than the freight on the amount of coal required for its production. The reason for this is that the coal can be transported and handled much more economically than coke. Furthermore, coke breaks up considerably during transportation and when handled repeatedly.

The smoke nuisance and the great area required by beehive ovens made the erection of these ovens at the point of coke consumption impracticable. With the by-product coke ovens this is different; there is no objection to the erection of these plants in or near cities; consequently it is reasonable to expect that the manufacture of metallurgical coke will be moved from the remote coke districts to the iron manufacturing centers, and hence many of the Ohio cities may expect to see by-product coke ovens and coke oven gas at their doors.

Domestic Coke.—It is not necessary to discuss the question of domestic coke, as you are so familiar with this subject. The results which are obtained, especially at Everett, Mass., in regard to the disposal of the large output, have been surprising to all of us. There is a crying demand in all large cities which are situated in or near bituminous coal districts, for a smokeless fuel, and on account of the high price of anthracite we have no doubt that the coke is destined to take the place of the more expensive anthracite, and of the unclean bituminous coal for all domestic purposes, in office buildings, etc.

It should be borne in mind that the coke is of a very much superior quality as compared with the ordinary gas house coke, and that it is successfully used for many purposes where gas house coke has met with no success.

By-Products.—The prices of tar and ammonia have kept up very well, notwithstanding the large output of these by-products now being produced by the various plants in operation. Most of the products of these plants have been sold on long time contracts.

Gas.—The quality of the gas has already been mentioned above. A net ton of average coking coal, giving about 9,000 cubic feet of gas, gives, on an average, 4,000 cubic feet of surplus gas. If the first fraction of the gas is collected separately, these 4,000 cubic feet have about 18 to 19-candle power without any enriching. The 5,000 cubic feet of poor gas used for heating the ovens, still have about 8 to 9-candle power. This candle power is almost entirely due to benzole vapors, which can readily be extracted; consequently, the candle power of the rich gas may be still further increased by adding this benzole. Of course, there is a limit in regard to the candle power of the gas, because coal gas of higher candle power becomes smoky, but we have found from actual experience that at Everett a 20-candle power coke oven gas does not produce objectionable smoke. For further information the above mentioned paper may be referred to again.

Conclusion.—You have honored me by asking me to start a discussion of this very interesting subject. It is impossible to exhaust this subject within a short paper, and I have consequently refrained from all technical details. It was my purpose only to call attention to the importance of this subject, especially in your district. I have endeavored to show that the by-product coke ovens are bound to come, both for the supply of coke to the Ohio blast furnaces and for the supply of smokeless fuel to cities. The by-product coke ovens have for many years been in operation, and remunerative as coke producers only even when the gas was wasted. This waste of the gas, however, has now been overcome because the quality has been brought up to such a degree that even the best coal gas manufactured by the old retort process cannot be compared with it.

As the erection of these plants in your district is bound to come, will the gas be wasted?

Mr. Thomas Littlehales, of Syracuse, N. Y., then read his written discussion on this subject as follows:

To the President and Members of the Ohio Gas Light Association: When your Secretary sent me an urgent request to say something on the subject of "Recent Developments in By-product Coke Ovens," it did not appear to me that I could say much more than I had said in the paper I had the honor of presenting at the Boston meeting of the American Gas Light Association, in October last, and it was only in the hope that the reopening of the subject here might lead to a discussion in which other members of the gas fraternity may be induced to express their views, pro and con, and throw more light on the question, that I appear before you now.

The incessant and imperious demands which the multifarious daily duties of a gas manager impose, prevent him giving to new subjects that lengthy and continuous investigation necessary to get at all the facts. Much has to be taken on trust, and often when experiments are made without sufficient knowledge beforehand of all the factors involved, they lead to costly and often disheartening experiences. Nevertheless we are indebted to the men who attempt them, because so much may be learned even by a failure, and there are but few, of even the most successful undertakings, that have not had a share of these costly and disheartening experiences in their early stages; but as "hope

springs eternal in the human breast," especially when that breast is supported by the backbone of the average gas man, he is not easily downed or disheartened although there is a streak of conservatism in most of us that leads us generally to prefer following well trodden paths, rather than to risk stubbing our toes against obstacles that may be obscured in untrodden ones.

An unusual opportunity having occurred to me for giving continued study, investigation and observations of retort oven working and results, advantage was taken of it, and the results and conclusions so reached are before my gas brethren in the paper referred to.

Before commencing investigating the retort ovens there was a pretty strong conviction in my mind that, as gas producers, the ovens were simply not in it with retorts; and if that were all there is to the question, viz., ovens as gas producers, the same position might probably be maintained to-day; but that is not by any means the case. Other factors than gas production have so important a bearing upon the question that one can safely use the old aphorism about "circumstances altering cases." And it may not be out of place to indicate to you the facts that changed my former views on the ovens as compared with gas retorts.

On looking into the retort oven working for the first time, the first thing that will probably strike a gas man will be the fact that, from the time the coal reaches the siding in the cars until the coke is quenched, every part of the coal and coke handling is done by machinery, except the pulling of the levers to open and close the valves letting the coal into the charging larries and again from these larries into the ovens. As he watches the filling of three larries, each containing a little over 2 tons, in a total of about 3 minutes, sees them emptied into the ovens almost as quickly, and when the charge is burned off sees the whole of the coke, from say 6½ tons of coal, pushed out and quenched in about 2½ to 3 minutes, and the oven doors then closed up again ready to be recharged in 4 to 5 minutes, he will begin to realize that the ideal of all progressive gas men, to substitute machinery for the arduous labor of stoking, is about reached; and mind you, the simplicity of operations being such as to enable any ordinary laborer, without previous training or experience, to perform them satisfactorily, it will soon begin to appeal very strongly to his common sense and judgment, to say nothing as to his ideas as a manager, as to its probable effect on the balance sheet at the end of the year. It seemed to me to be so plain and self-evident that the proverbial "blind man on a galloping horse" could almost see it.

The questions will then arise about the relative areas of ground occupied? The relative cost of construction to gas made as compared with the retorts? The fuel account? The wear and tear charges, as compared to retort methods? And then when all things are taken into account, losses and gains considered, by which method can most money be made, and under what conditions can the ovens be advantageously operated?

According to my figuring, when the whole thing was summed up, the advantage was largely on the side of the ovens; in short, that, given an outlet for coke, the oven operators could at a fair profit put gas into the holders of a gas company at a price sufficiently lower than a gas company can make it, as to have an important influence on the profits of a gas company, or in reduction of the price of gas to the consumer.

There do not appear to be any new facts or figures of importance to present to you, other than those given in my paper at Boston, and as that paper has been printed in the American Gas Light Journal, Nov. 25th, 1901, and "Progressive Age," Dec. 16th, 1901, it is assumed that they have been before you, or that you can readily refer thereto, so your time will not be taken up in going over them again, further than to give a resume of the facts, but the subject will be dealt with now more as a continuation of that discussion.

The paper showed, from one United States Government report, that the coal used annually in the United States for coke making, was upwards of 30 millions of net tons, which was 14 times a greater quantity of coal than is used in 433 cities and towns in coal gas making; and that the coke made therefrom in coke ovens amounted to about 20 millions of net tons; and that, assuming the recovery of 4,000 feet of gas per net ton of coal, at present wasted, it amounted to 120,877,372,000 feet; more than sufficient to furnish twice over all the gas at present consumed in the 40 largest cities in the United States, allowing a consumption of 4,200 feet per capita of population. And that this was not overestimated it was shown, from another United States Government report, that the consumption in 433 various sized cities and towns in the United States gave a total of coal gas, oil gas and water gas made of 50,385,000,000 feet, while the waste, on the basis before indicated, was 120,877,000,000; so the wastage would more than supply the 433 cities and towns twice over, and that the further annual increase in coke making involved an annual increase in the gas wasted nearly sufficient so supply the output of 25 of the largest gas companies in Massachusetts, with an actual average consumption of 2,240 feet per capita per annum; and it appeared as though the question resolved itself more largely into one of the decentralization of coke manufacture than anything else, and of carbonizing the coal at the points where the waste gas and other products could be marketed.

You all know that an engineer in laying out a new plant for any purpose is supposed to take all the conditions and peculiarities of that special situation into account, so as best to adapt things to the requirements of that particular case, to enable him to obtain the largest returns from the capital invested; so as soon as sufficient acquaintance with retort oven working and results had been obtained I started to work in this wise: Assuming a large city at a distance, of which all the gas making data, cost of material, labor, coal, etc., were available, and assuming that an extension of plant of a capacity of 2 millions of feet per day had to be provided; also, that a knowledge of what retort ovens could do was desired. On this assumed basis, careful estimates were prepared of a coal gas plant for 2 millions of feet per day, and given a certain price at which gas had to be put in holders, figuring out what return should be obtained on the investment on the ordinary retort plan. The same course was pursued with the retort oven equipment, figuring everything out on similar or properly corresponding basis. The results showed that under the conditions of that place, gas from the ovens could be put in the holders with a profit at a price which would mean an absolute loss on gas retort methods. The make was then cut in two, and figured out again on 1 million feet per day, and the ovens still had the advantage as distinctly as before. Again and again the capacity was cut in 2, and also figured on each sized plant and with different costs of coal, and in every case, given the disposal of the coke, the ovens were ahead. The data and calculations were submitted to those abundantly able to criticize them, and the soundness of my position and the correctness of my figures were admitted. The subject has been looked into from every standpoint I could think of, and there is always one condition that will enable a *good* retort oven system to be operated successfully, in very many places, viz.: Disposal of coke, and seeing that retort oven coke has been abundantly demonstrated to be fully equal to that from beehive ovens for metallurgical requirements that goes a long way toward securing the necessary disposal of coke.

The fact should be borne in mind, that in Germany (and there is no other country where science is more thoroughly applied in manufacturing operations than in Germany) by-product ovens have literally driven beehive ovens out of the field.

As an instance to show how metallurgical coke users regard the quality of retort oven product, as compared with that from beehive ovens, the following incident will show: On a recent occasion a certain firm requiring accommodation of a few cars of foundry coke, appealed to another large firm using both beehive and retort oven coke to help them out. The answer came that they would let them have beehive, but could not spare any from the retort ovens, which they preferred for their own use.

The main question, then, of the successful and profitable operation of retort ovens is the disposal of the coke at a fair, moderate price. Given that, all other difficulties can be overcome. The remarkable experience of one gas company in this State, is well worth bringing to your notice, where, notwithstanding that soft coal is cheap, the gas company, by wise policy and able management, has so developed the coke trade that not only does it find a ready market for all it produces at satisfactory prices, but purchases large quantities from other gas companies, and from coke ovens, to supply the demand; and what can be done in one place can surely be done in others, if the same wise policy is pursued.

Many gas men who have seen retort ovens in operation when the gas was not being marketed, and noticing the comparatively low illuminating power produced under those conditions, often not more than equal to 8 or 10 candles, have gone away with the impression that that was the normal condition and quality of gas from retort ovens, whereas it was only the conditions then prevailing which could readily be changed, if requirements called for so doing; because under the then conditions the gas was of but small consideration. As a matter of fact, gas of just as good quality and illuminating power can, by proper manipulation and working, be as easily obtained from retort ovens as from gas retorts; and by the separation of the gases, using the richer for illuminating, and the poorer for heating the ovens, a considerably higher illuminating power can be obtained from the ovens than is generally obtained in gas retort operations. This fact was discovered years ago, and has since been put into practical operation. Analyses of the gases produced by the Paris, English and New York Gas Com-

panies, and of those from retort ovens, show that they are all practically of the same general character, in every respect.

It has been the custom to build retort ovens in the open air, without any covering to protect them or the men operating them from the weather. Gas men generally will be disposed to doubt the wisdom of this practice, and the strongest excuses I can see for it are the saving in first cost, and that it was the custom to build beehive ovens in this manner and retort oven constructors were content to follow suit. If it were thought better on the whole to have a roof over them, there is nothing in the way of its being done except the expense; and probably the interest on the extra cost for the roof would be made up by the saving of fuel in winter time, and by the saving in general wear and tear, to say nothing of the protection to the men during stormy weather. Few gas men would think of running their retort houses for a single winter season without a roof.

While I do not for a moment wish to withdraw from the position previously taken, that the retort oven is to play a very important part in the gas manufacturing industry of the future, I am inclined to think it will be safer and better for gas companies and oven operators to work together on some equitable basis of co-operation to their mutual advantage rather than for gas companies in the present stage to assume risks and responsibilities with which they are not yet familiar. Experience, which in many cases has been costly, is worth money, and often much more than money.

Where conditions exist for such co-operation as suggested, gas can be put into holders cheaper than the gas companies can make it; often enough cheaper to make an increase of from 2 to 3 per cent. per annum on a fair capitalization.

Mr. C. W. Andrews, of Hamilton, O., then read the following contribution on this subject:

Your Programme Committee has requested me to write a short paper as a continuance of the subject of coke oven gas, already opened by Dr. Schniewind, and I feel that the most interesting way to present this matter to this Association, would be to give you a sketch of the results we are obtaining at Hamilton.

In 1900 we were confronted by the necessity of rebuilding our old plant, as we had outgrown its carbonizing capacity. As the maximum combined output of the city is at this time nearly 500,000 daily, we decided that it would be a better policy to build a large plant on the latest lines, of sufficient capacity to take care of the total sendout, and also the probable increase of a number of years.

After due investigation of the Otto-Hoffman system, as installed by the United Coke and Gas Company, New York City, it was adopted as being the best system for the conditions surrounding our location.

As you are probably aware, the Hamilton-Otto Coke Company started the erection of their 50-oven plant in July, 1900, and the first charges of coke were pushed the latter part of April, 1901, the plant, therefore, taking 10 months to erect and put in operation. This was considered fairly good time, considering the state of the market.

In course of a couple of weeks of operations, we were able to begin the supply of gas to the Hamilton Gas Light and Coke Company, which Company had already made a contract for its supply with the Coke Company.

We found that the candle power was subject entirely to our wishes, as we were able to maintain any desired candle power up to 19 without any difficulty, and the calorific value of the gas, above that produced by the retort process formerly used, was very quickly demonstrated, as expressions of satisfaction were constantly received from our patrons, and had not a long and severe strike of the machinists interfered we should have put out a very large number of gas stoves in addition to those we did in our regular course of business.

During the first few months of operation we made a very large percentage of domestic coke, for which a market has easily been found, not only in this vicinity but also throughout the West and Northwest.

The foundry trade, which we expect to make our main business, was, of course, gradually worked up, until at the present writing we have all the orders necessary to operate the plant on practically foundry coke, the amount of domestic coke now being made not being sufficient to supply our local demand.

The gas produced at the Coke Company's plant is conveyed by a 3-mile, 8-inch pipe line to the old works of the Gas Company, where it is purified in the usual way and forced into the storage holders.

In this connection it might be interesting to know that we are using high pressure exhausters for this service, which fact enables us to force gas at the pressure of 8 feet of water if desirable. This, of course, removes most of the difficulties ordinarily contended with on low pressure lines of this kind, as condensation or deposits of naphthaline can be forced out of any ordinary traps and carried forward to the drip pots. As this is a new proposition in this part of the country, you will no doubt be interested to know what were the reasons which induced us to go into this new method of manufacturing gas.

Hamilton, as you probably know, has two gas companies, one operated by the Hamilton Gas Light and Coke Company and one by the City of Hamilton, each having in conjunction an electric plant, so that either Company is prepared to supply either gas or electric lighting, as desired.

The Hamilton Gas Light and Coke Company, however, are operating quite a large power circuit in addition, they having over 400-horse power in motors.

Their station contains a gas engine of 150-horse power, which is used in connection with a steam plant for this service, as we consider it advantageous to use the gas in a large engine of this kind.

The City of Hamilton put its gas plant in operation in 1889, at that time reducing the price of gas to $1. This was met by our Company making the price 95 cents, although the combined output at that time was only about 20,000,000 annually. From that time until '95, the price remained at the figures quoted.

In the latter year that price was again reduced by the city to 80 cents net, which price was met by our Company, without any further reduction, and this price still remains in force. As a result of these low prices, the output of gas has increased amazingly, and with every indication of a continuous growth.

Since the erection of our plant, the South Jersey Gas, Electric and Traction Company have started the erection of a 100-oven plant at Camden, N. J., which will be in operation early this summer, and will supply gas to a large number of New Jersey cities.

The Maryland Steel Company is also erecting a plant of 200 ovens at Sparrow's Point, near Baltimore. The surplus gas from this plant will also be used for illuminating purposes. There are, therefore, four plants either in operation or under construction for the purpose of furnishing illuminating gas.

Discussion.

The President—Any comments, gentlemen?

Mr. Carpenter—Mr. Littlehales says in his paper that a coke oven plant, producing 2,000,000 cubic feet of gas in 24 hours can put gas into the holder at a price that a modern retort plant would work at a loss. I would like to ask Mr. Littlehales the cost of labor employed in that plant—that is, in the retort plant; and at what price he figured the gas coke.

Mr. Littlehales—Replying to Mr. Carpenter I estimated the operation of a plant in a certain city regarding which I had personal knowledge of all the conditions. Taking the coal and labor at the same price, and selling the coke at the same price, and assuming a contract to put the gas into the holders at a certain price, a substantial profit could be made on the oven plant where it would be an absolute loss in the retort plant. Now have I made myself clear? I am not prepared to give all the figures involved, but will state generally that every factor was taken on the same basis—the cost of labor, the cost of material, and selling price.

Mr. Carpenter—Then as I understand it you were figuring the modern coke oven plant as against the existing gas plant.

Mr. Littlehales—I was.

Mr. Carpenter—And not against a modern gas plant?

Mr. Littlehales—I beg your pardon. It was as well equipped a gas plant as there is on this Continent.

Mr. Carpenter—Had it a corresponding amount of machinery for handling coal and for charging it into the retorts?

Mr. Littlehales—Yes, sir; only I wish to say about the coal handling question that it is a double-edged sword. A coal handling plant in my judgment in a gas works is an expensive luxury, except a very large company. There are a great many places where it would not pay. I had occasion to make estimates on an installation of that kind where our coal was all taken in in a very short time, probably within 3 months, and while we could have have handled it at a smaller rate per ton during that time, yet we have to pay interest and allow for deterioration on machinery for the 9 months it was not working. There are a great many points where machinery can be used very advantageously, if it can be kept working 365 days in the year. It would very much reduce the cost of hand labor, but where it can only be used for a short time hand labor I think is far more economical.

Mr. Carpenter—I did not intend to ask Mr. Littlehales the cost of making the gas in his coke oven; but for obvious reasons I think it

would be very interesting for him to tell us at what he calculated the labor in that ordinary gas plant and at what figure per ton of coal carbonized, or per 1,000 cubic feet of gas.

The President—You want, as I understand, the comparative cost of handling coal per ton, with labor included, in a coke plant and in a retort plant.

Mr. Carpenter—No; that is not it, Mr. President. I do not care to know the cost in the coke plant at all, but simply at what figure Mr. Littlehales put in the cost of making the gas in the ordinary gas plant.

The President—There are some things here we talk about only in executive session. If you want to know the cost of labor per ton of coal, we are free to talk about that.

Mr. Carpenter—That is what I want.

Mr. Littlehales—The best answer to that, Mr. President, is that I took the company's balance sheet per year for actual expenditures for labor. It was a company I knew to be well managed and economically managed. I took its balance sheet and considered every factor in it, so I know the bottom facts of that company's working, and I also assumed a contract to put the gas into the holders at a low price, very much lower than that company was making it. I won't say how much lower because it was so much lower that you would be rather surprised, but, taking that balance sheet for a year, and analyzing it as I did, I found the oven put it in very much less, and the very best evidence of that fact, gentlemen, is this, that very recently arrangements have been made with that company to put in, to the extent of 2½ million feet a day, gas from coke ovens at a considerably less rate than the gas companies to whom it is being supplied can make it. That is the best evidence you could ask. Somebody has said that "the proof of the pudding is in the chewing of the string," and the best way for a man to back up his argument is to show what is actually being done. That contract has been undertaken to the extent of 2½ millions per day, at a price less than the gas company can make it. I think I have proven my point, Mr. President.

Mr. Miller—I would like to ask Dr. Schniewind what would be the relative value of coke produced in beehive ovens as compared with by-product ovens for foundry or metallurgical purposes—coal in both plants from the same mine; in other words, of the same grade. What would be the relative value of the coke?

Dr. Schniewind—We have been carrying on very large tests at Johnstown, Pa. I understand your inquiry to be whether there is any difference in the relative value of coke produced in retorts ovens from certain coal and by-product coke produced from the same coal.

Mr. Millller—No; my question is the relative value of the coke from a by-product oven and the beehive oven, using the same coal.

Dr. Schniewind—With your permission, Mr. President and gentlemen, I will enlarge on this question a little bit. You know that beehive ovens are not good coking ovens for a great number of coals, so in order to answer this question once for all, I will say that we have taken the very best coking coal which can be found for the manufacture of metallurgical coke; namely, the Connellsville coal. We coked about 3,500 tons of this coal in our Otto-Hoffman ovens and tested it. After a trial period on the Connellsville beehive coke per ton of iron produced the coke consumption on the by-product coke was about 98 pounds less, with the capacity of the furnace increased 8 per cent. The reason for this is chiefly the greater density of the by-product coke. It is made in a deeper layer, and consequently denser by compression, in consequence of which it takes less volume in the blast furnace, allowing a larger charge to pass from the blast furnace in the same period of time. The Cambria Steel Company operated 160 ovens of our type, and have used our coke in comparison with beehive coke for a very long period of several years, and recently when an extension of the plant was under discussion they once more made tests for several months. They took two furnaces, running them during the same month, one on beehive coke and the other on by-product coke. They took it at the same period of time in order to have no difference in weather conditions which might very materially influence the operation of the furnaces. After this was done and the advantage of the by-product coke was shown by the operation of the two furnaces, we changed around. The furnace which was previously operated with by-product coke was used to test the beehive coke and *vice versa*, in order to eliminate any difference in the operating of the individual furnaces, and the same results were obtained. The by-product coke was found to be ahead.

Mr. Miller—In that case I would like to inquire why beehive oven coke sells from 40 to 60 cents per ton more than by-product coke for foundry purposes?

Dr. Schniewind—Simply because it is a new thing and by-product coke has to overcome a great deal of prejudice. We have about overcome this prejudice. The by-product coke ovens when first introduced were stated to make a coke very much inferior to beehive coke, and we have had to make inducements in the price of coke in order to find a market. But recently we have had to make no such reduction. We are now getting just the same price for the by-product coke as that obtained for the beehive coke, because we have demonstrated the quality of both cokes.

Mr. E. D. Johnson—Regarding this matter as to the use of coke, I will simply say we have in our Connersville foundries adopted the by-product coke and find that the statements of Dr. Schniewind are fully borne out. In fact we prefer the by-product coke for use in our foundries.

Mr. Andrews—In this connection I might say that, although we have only been in operation a short time, we have developed a market, as stated in my paper, for our coke, which is largely in excess of what we can supply, and at the present time we are not taking contracts at less than the Connellsville coke rate in most of the territory we are supplying. Of course, at some points we are still developing our business, and where we are making special rates to get in, but in the other part of our territory our prices are as high as the Connellsville coke prices at the present time.

Mr. Littlehales—I can indorse every word of Dr. Schniewind in respect to his experiences over the relative efficiency of retort oven coke as compared with beehive. The same thing has been demonstrated in at least a dozen places. I instanced one in my paper where the parties were using both. The question Mr. Miller raised about having to sell it at a lower price is as universal as business. Wherever a new competitor appears in any line, I do not care what it is, if he comes in as a new competitor, he has, at the start, to put his prices lower, because there is always a reluctance to change. A man or a firm who has been doing business in a certain line does not care to change from that line unless he can get an advantage. What advantage can you offer if you have a new article on the market? You have to give them a little lower price until you satisfy them that your article is the right thing. Then it will fix its own price. It is no reflection on by-product coke that in some cases it has to be offered at a lower rate to induce its sale. That is simply common to all kinds of business the world over.

The President—What else, gentlemen? Any other comments on this subject?

Mr. Miller—Inasmuch as Mr. Carpenter has been unable to get a direct answer to his question, I would like to ask Mr. Littlehales what large gas works in the State of Ohio it was in which he made his comparison?

Mr. Littlehales—I did not say it was a works in this State. I said in this country. My estimates ordinarily are taken for carbonization at 95 cents per ton in the gas works. And from a great many gas works from which I have the data I find it exceeds that in a great many more cases rather than where it falls below it, where I have been able to obtain data; but where my estimates were made they have been made on the basis of 95 cents for carbonization wages in gas works. The case I referred to was the actual cost of wages paid in that locality. I was simply giving the result as a comparison of the two methods and I could not make a better estimate than by taking actual facts. I know these works are run economically, but 95 cents per ton is the cost which I estimated.

Mr. Miller—I wish to state in reply that although that plant may have been operated economically, it was about 80 per cent. higher than it should have been with the modern coal gas plant.

Mr. Carpenter—I would like to ask Mr. Littlehales if that 95 cents per ton is the total works' labor, or the cost of the retort labor?

Mr. Littlehales—It would embrace all the carbonization wages, which include the coke handling, the getting in of the coal, the charging of the retorts and taking away the coke from retorts, and all the labor pertaining to carbonization which would apply in both cases; and with all due respect to Mr. Miller, except where machinery is employed, I would like to see some data by which he could show me how it can be done 80 per cent. cheaper. I have figured it out from a great many standpoints and find that the coal handled per man in the average retort system will run, if I remember right, about 2½ tons per man per day. It is easily figured out. Most of us have to pay about the same general run of wages for a man, and I do not see how it is possible to cut 80 per cent. off, as even inclined retorts do not gain that.

Mr. Miller—Mr. Littlehales did not quite understand me. I did not say he could cut 80 per cent., but I said that 95 cents was 80 per cent. too high.

The President—In other words, about 50 cents would be right; is that correct?

Mr. Miller—Yes, sir.

Mr. Littlehales—I have nothing to say to that, Mr. President. I am speaking from facts. That is all I have to say.

The President—What figures did you have in mind, Mr. Miller, if you please?

Mr. Miller Approximately, 50 cents.

The President—Mr. Carpenter, do you think that figure is a representative one?

Mr. Carpenter—Well, the reason I asked that question of Mr. Littlehales was because I was afraid he was making comparison between an ordinary coal gas plant that was a little out-of date and a modern coke oven plant which was thoroughly equipped with labor saving machinery. I should think Mr. Miller's figures, from what I know of the matter, are a little high, if anything.

Mr. Littlehales—Perhaps there may be some little discrepancy which is the cause of the misunderstanding on this point. My figures on coal gas or retort working do not apply to where water gas is used in conjunction. I am speaking of straight coal gas.

The President—I think the point they are trying to bring out is this: That you are taking a works where they are using no drawing or charging machinery.

Mr. Littlehales—Certainly.

The President—And the carbonization labor of works of that sort will often run $1.10 per ton of coal, while taking a very conservative estimate of figures which are being obtained in this country you can cut it down to 50 cents a ton, including all coal carbonizing labor, with drawing and charging machinery, and I personally believe that you can cut it down to 35 cents.

Mr. Littlehales—I believe that is possible, and I wish to say that there are only probably 2 or 3 places on the Continent of America where the gas is made in sufficiently large volumes to justify that, but in the average gas works, without machinery, I still hold that 95 cents would be lower rather than higher than the average.

Mr. Carpenter—Quite a number of coke oven plants have been built of late, but there have been very few modern installations with retort houses equipped with machinery. Possibly a few years hence there will be a few plants, so that we will be able to make a respectable comparison. I speak of small sized plants now in reply to Mr. Littlehales' point, with reference to small plants.

Mr. Littlehales—I referred to a plant of two millions a day.

Dr. Schniewind—We have lately in our modern plants adopted a great number of labor saving devices, so that I think I can answer this question to some extent. We figure and can bear this matter out by facts that, taking the coal from the railroad cars, dumping it, passing it through the crusher, elevating it into a bin, charging it by electrical machinery into the coke ovens, raising the doors, pushing the coke out on a platform, quenching the coke, dumping it into railroad cars, and, furthermore, tending to the gas as far as condensation of it, cleaning it of pitch, etc., our labor costs us 22.5 cents per net ton of coal carbonized. That is, with all modern equipments, such as electric pushers, electric drawing machinery, electric charging machinery, etc.

Mr. Carpenter—Taking these figures, and figuring on 4,000 cubic feet of gas per ton, against 10,000 that you get in the ordinary retort house from the gas end of it, I fail to see where the profits come in.

Dr. Schniewind—If Mr. Carpenter will also take into consideration the other side of the balance sheet, and make due allowance for tar, ammonia and other by-products, with the greater quantity of coke that the ovens turn out, he will see that it accounts for the difference which he mentioned.

Mr. Littlehales—In other words, Mr. Carpenter has not yet discovered where the milk is in the cocoanut. I would like to explain, Mr. President, wherein the discrepancy occurs in Mr. Carpenter's mind. If you sell 900 pounds per net ton of coke in the average gas works, that is about all you sell, but you can sell 70 per cent. of its weight from by-product ovens. I think if you will figure that up when you get home, and take a little time to it, you will find where it comes in.

Mr. Carpenter—Another point that must be considered, is the relative cost of installation of the two plants. You have to pay interest on the money you have invested in the plant.

Mr. Littlehales—That is true.

Dr. Schniewind—I want to say, Mr. Carpenter, of course, local conditions will govern. The coke oven is not the salvation for every single point. As has been brought out several times, Mr. Carpenter should bear in mind that millions of tons of coke are being produced in this country with an absolute waste of tar, ammonia and gas, and they have gone on successfully so far, notwithstanding this waste. Furthermore, that by-product coke ovens are operated by the thousand with a waste of all the gas, and notwithstanding this waste, they are earning large dividends. Bear these facts in mind, and you will understand that, if the gas is put into proper shape, it is done without any expense to speak of at all, and that there must be a great saving resulting therefrom.

Mr. Miller—I would like to ask Dr. Schniewind what would be the effect upon the price of tar and ammonia had all the coke been produced by the by-product ovens rather than the beehive ovens.

Dr. Schniewind—The demands for ammonia are simply in their infancy. The bringing of more ammonia and tar into the market has increased the price rather than decreased it. When we started out with the first plant, which was built in 1895, and enlarged the plant at Johnstown—the Cambria Steel Company—everybody said that the ammonia market would go to pieces, and so it did temporarily. The introduction of the by-product coke ovens into the United States made a very marked impression on the price of by-products in the beginning. After the erection of the Cambria plants, and when the Glassport plant came into operation, the price of sulphate of ammonia fell from about $53 to $40 per ton. Looking into the cause of this trouble, we found that it was due to the clever manipulation of prices by brokers, bidding the two products against each other. We prevented a recurrence and the price of sulphate of ammonia has continuously gone on until at present, it is $58 or $59 per ton, and there is an increasing demand all the time. The increased demand is so large that the present product is not nearly sufficient to supply it. In other words, the production of sulphate of ammonia since 1895 has more than doubled. Furthermore, I would like to call your attention to the fact that immense quantities of nitrate of soda, which is another nitrogenous fertilizer, are brought into this country. The present importation, I think, is about 400,000,000 pounds per year. About 75 per cent. in other countries is used for fertilizing purposes. I speak especially of Germany, which uses about 450,000 pounds. Now, as soon as the sulphate of ammonia, which is a domestic product, is brought properly before the farmer, it will have exactly the same result as in other countries. It will be adopted by farmers for fertilizing purposes because it has been demonstrated that it is a good fertilizer. The domestic production of the sulphate of ammonia by gas works is comparatively small, and the product from the coke ovens coming upon the market at first caused alarm, but this has been entirely unfounded, because the entire coke works' production is not only disposed of mostly by long time contracts, but the importation of the sulphate of ammonia into this country has greatly increased since the introduction of by-product coke ovens. This proves that the supply created the demand. The consumption and production of the sulphate of ammonia in Germany and England are very much larger than in the United States, notwithstanding the fact that the United States has become the leading manufacturing country of the world. In regard to tar, it may be stated that the production in England and Germany is also very much larger than in the United States. England has produced per year about 750,000 tons of tar; Germany about 450,000 tons, while this country has produced about 200,000 tons, notwithstanding we have a very much larger population and very much larger industrial development. It is only a question of the supply creating the demand. The use of tar is continuously increasing for many industries, and since the introduction of the by-product coke oven no material reduction in the price of tar has been experienced.

Mr. Carpenter—I do not wish to be misunderstood altogether in this discussion. I do not question the field of the by-product coke oven, but I do believe that in any case it comes down to a question of whether you are in the gas business or whether you are in the coke business. I think you can get from a pound of coal, to start out with, enough in the ordinary retort process as used by gas companies to put gas into the holder just as cheap as you can by the coke oven process. If you want to make coke, or if you are going into the coke business, then that is another matter to be considered.

Mr. Miller—I think Dr. Schniewind did not quite understand my question. I asked particularly what would have probably become of the price of coke to-day had all the coke been reduced by by-product coke ovens last year rather than by beehive ovens.

Dr. Schniewind—I beg your pardon. I thought your question referred to the by-products. I want to say that this question may be answered by the results which have been obtained in other countries, where by-product ovens have been adopted almost universally; especially in Germany is that the case. There is absolutely no difference in the price of beehive coke as compared with by-product coke. In my paper, in speaking of that feature of the discussion, I had reference to the condition a few years ago when beehive ovens were still in existence. Now, all of the beehive ovens have disappeared in Germany. There are absolutely none. And, to answer your question, by illustrating the

experiences which have been had in Germany, I will say that it has brought about no effect on the price of coke; absolutely none. It remained the same. In other words, as I understand your question, it is whether the by-products, in order to find a market, will have to be lowered, and also the price of coke will have to be so lowered in order to find a market. I have no hesitancy in stating that that has not been the case. The price of coke has always been established on the beehive basis.

Mr. Littlehales—Allow me just one word along the same line. I would like to answer Mr. Miller's question in this way: If 30 millions net tons of coke are used in metallurgical purposes, it matters not, in affecting the price of that article, whether it be made by the beehive or by retort ovens. But if that 30 million net tons that were carbonized by the beehive ovens, from which the tar, ammonia and gas were wasted, it would simply mean a saving in that operation of enough gas to light 433 cities, allowing them 4,000 per capita. As far as the effect on the price of coke is concerned, I cannot see how it would affect it, whether the 30 million tons were made in beehive or retort ovens.

The President—Anything more, gentlemen.

Mr. Littlehales—I would like to hear from the President.

The President—I have troubles of my own. Mr. Miller, do you want the last word, or Mr. Carpenter, do you want it? You have divided yourselves on opposite sides of the house. I thought we were going to have a fight, but I have been disappointed. Mr. Miller, you seem to have something on your mind, or are searching for some statement in Dr. Schniewind's written discussion. If you are looking for something, we will wait for you.

Mr. Miller—I was thinking there was a statement in Dr. Schniewind's paper to the effect that the coal in a modern retort house had to be crushed.

Dr. Schniewind—No; I speak of recrushing the coke for coke ovens; not in the retort house. My paper doesn't say that.

The President—We have a contribution from Mr. D. R. Russell, of St. Louis, Mo., on a subject which we had left out of our programme. We attempted to get a discussion on the relative merits of full-depth and half-depth benches. We asked four competent people to contribute on that subject, but none of them responded. Mr. Russell brought his to the meeting, understanding that this was simply to be a written discussion presented on the floor and not previously printed. I will now ask Mr. Russell to read his contribution on that subject.

Mr. D. R. Russell—I will say, Mr. President, that I was away from home when I received the notice from the Secretary requesting me to say something on this subject, and I was not able to get the data until too late to send it in for publication.

Mr. Russell then read the following contribution, on the questions

IS THERE ANY ECONOMY IN FULL-DEPTH BENCHES OVER HALF-DEPTH; AND WHY?

Mr. President and Members of the Ohio Gas Light Association: At the request of your Secretary I have prepared a few notes in answer to the questions, "Is there any Economy in Full-depth Benches over Half-depth; and Why?"

I consider that it depends entirely on local conditions whether full-depth, recuperator benches or half-depth, recuperator benches are the better; or, in fact, if any recuperator benches are better than the ordinary free fire. In a very small gas works, producing say not over 10,000 to 15,000 feet per day, I would not advocate using recuperator benches at all, as the saving would practically be nothing, and no compensation would be derived from the increased cost of installation.

Where the output reaches a maximum of 80,000 cubic feet a day, and from that up to 250,000 cubic feet, I would recommend half-depth, recuperator benches. For the former output probably a bench of 4's and a bench of 6's would be the best calculated to handle the production with economy, and for the latter from 4 to 5 benches of semi-recuperator 6's, with furnaces in front or rear. From 250,000 to 500,000 cubic feet, I would advocate full-depth benches of 6's. This would also cover the construction sometimes called three-quarter depth 6's, which, however, are practically full-depth, and give about as good results as a bench which may be constructed with possibly a foot or more of deeper furnace and recuperation.

When the output exceeds 500,000 cubic feet I would unquestionably advocate either full-depth benches of 8's, or full-depth benches of 9's, preferably the latter. I am aware that there is considerable prejudice against benches of 9's, but my opinion is that the failure to get all around good results from 9's is from the fact that the benches are either improperly designed, constructed or operated. There are sufficient benches of 9's which have been under continuous operation for some years in the United States which have given most excellent satisfaction, and whereas it is generally found that the center bottom retort will give out before the balance, it is a fact that you will get at least 90 per cent. as much gas from this said retort as from any of the other retorts in the bench, and when it becomes necessary to block this retort off you have merely exchanged a bench of 9's for a bench of 8's for the few months of life remaining to the retorts.

The average cost of installation of benches of different kinds including only the benches proper, which covers the arches from the top of the foundation, the retorts, settings, iron work and everything erected complete, ready for off-take connections to be made, but not including retort house or floors, is about as follows:

Semi-recuperator 6's	$31.66	per	1,000	cubic feet capacity.
Full-depth 6's	41.66	"	"	"
Full-depth 9's	33.00	"	"	"

I think a fair average, year in and year out, of the amount of coke used under the benches, per 100 pounds of coal carbonized, would be, for:

Semi-recuperator 6's	17½	pounds,	or	27	per	cent. of the coke made.
Full-depth 6's	16¼	"	"	25	"	"
Full-depth 9's	13	"	"	20	"	"

Figuring on an average output of 500,000 cubic feet per annum, and estimating on securing 65 per cent. weight in coke from the coal carbonized, you would have for sale the following amounts of coke per annum, and, assuming that the coke would be sold at $3.50 per ton, the saving between the different kind of benches would be as follows: Coal carbonized per annum, estimating 5 cubic feet of gas per pound, 18,500 tons, producing 12,000 tons of coke:

From half-depth benches, 6's, there would remain for sale	8,760 tons,	at	$3.50	$30,660
From full-depth benches, 6's, there would remain for sale	9,000 "		3.50	31,500
From full-depth benches, 9's, there would remain for sale	9,600 "		3.50	33,600

The estimated saving, therefore, for the year is:

For full-depth 6's over half-depth 6's	$840.00
For full-depth 9's over half-depth 6's	2,940.00
For full-depth 9's over full-depth 6's	2,100.00

It is very difficult to secure accurate information as to results obtained, but above figures are taken from the average results reported from a number of gas works.

Referring to the local conditions which should govern the installation of different classes of benches, there are sometimes many reasons why it is preferable to use one or the other kind of construction. It is sometimes the case, owing to the lay of the ground, that railroad switches may come above the level of a stage floor, and that the whole coal supply may be above the level of a stage floor. In this event it is more convenient to have the full-depth benches, even where only a few are required, the coal coming in at the stage floor level, the coke being dropped through into the basement and taken out on the yard level, which, owing to the character of the ground, may be many feet lower than the coal supply.

Another advantage of full-depth benches is that you can install, if desired, coke conveying machinery beneath the stage floor, which cannot be well adapted to half-depths, as it interferes with the operation of the furnaces, the height being so limited.

On the question of repairs there is another advantage for the full-depth benches. Whereas you can, where half-depth benches have not been abused, reset the retorts over the recuperation a second time, it is a question if a third setting should go in; but with full-depths you should be able to reset three times, making four settings before rebuilding.

I would not advocate attempting to build either benches of 8's or benches of 9's with anything but full-depth furnaces and recuperation, as it is impracticable to design either class of bench on half-depth lines, without having the retorts too close to the furnace arch, and being unable to carry sufficient fuel to assure the production of carbonic oxide in the furnace, and the danger of the fuel bed becoming so thin as to cause direct combustion and the destruction of the furnace arch and the retorts. This does not apply to benches of 8's or 10's, built in 2 rows of retorts set vertically 4 or 5 tiers high, which are used abroad in some instances, and which are to be installed in the United States, for the reason that where such benches are operated it is obviously necessary to utilize charging and drawing machinery, which brings in an element of expense that I assume is not intended to be covered by this question. Such benches, I believe, however, would also necessitate the deep furnace and recuperations to get high and even heats with economy of fuel.

The President—We have a written discussion on the subject of "Isolated Generator Firing of Benches," in which one of the contributors in

a measure sought to touch upon this point. I think it would be advisable to read the contributions on that subject, which plan will open up the whole proposition of fuel economy in the retort house, and the complete subject, including the contribution by Mr. Russell, can be discussed at the same time.

At the request of the President, Vice-President Andrews assumed the Chair.

The written discussion by Mr. W. E. Steinwedell, of Belleville, Ills., on the subject of

ISOLATED GENERATOR FIRING OF BENCHES,

was then read as follows:

To the Ohio Gas Light Association: Gentlemen—Your President has asked the writer to start a discussion on "The Firing of Coal Gas Benches with Isolated Generators," and the following views are submitted for this purpose.

The first cost in this style of construction depends on whether the primary and secondary air is heated, and will be increased if a duplicate set of generators is installed for facilitating repairs and getting an even production of generator gas.

The question of the number of retorts each generator or pair of generators will most economically heat has not been established. In cost of operation the repairs on the benches will depend on the evenness of temperature maintained; but should be small, as retorts will last for a long time if fired with a steady supply of gas. The generator requires new lining and grate bars occasionally.

The labor for drawing and charging is the same with benches of the ordinary type, whether horizontal, hand-charged, machine-charged or inclined settings. The supervision of attending the generators, regulating the heats of the benches and running forced draught in some cases should be lower than with individual generator settings.

The fuel for firing can be either coal or coke, excepting when the construction produces tar and lampblack in the flues when fired with coal. Radiation plays an important part in fuel consumption.

The reliability of these benches under continuous operation depends on a constant and even production of gas in the generator to produce steady heats, and the valves for controlling the entrance of the generator gases into the bench should close air-tight to prevent an explosion.

Mr. Henry L. Doherty then read the following contribution on the subject under discussion:

Isolated generator bench firing has been frowned upon by gas engineers to a degree entirely unwarranted by results obtained in similar applications of producer gas firing in other industrial plants.

There is little in Mr. Steinwedell's views which I care to take exception to, but I do not think he has fully set out the advantages of producer gas firing, and has entirely overlooked the saving which can be made by the use of breeze and other low cost and less valuable fuel which can be used in a producer, but cannot be used in our present furnaces advantageously; and he also omitted to call attention to the income that might be derived from tar and ammonia, to be obtained from producer gas furnaces where coal is used. On the other hand, he did not call attention to one serious objection to producers, which is their small capacity per unit surface of grate area. From 10 to 20 pounds of fuel is about all they can gasify, and 15 pounds might be taken as a fair average.

The first cost of installation for producer gas firing would be more than our present cost, if we had to adapt this method to our present installations, but I believe it would be less if we were building anew with this end in view.

The furnace labor and attendance should be very much less than with individual settings. It is less labor to care for one large furnace than several small ones, and especially where this large furnace, or battery of large furnaces, can be properly situated and arranged for the reception and stoking of the coal, and the disposal of the ashes. Gas firing at Columbus, O., has demonstrated that a much longer life of settings may be expected, and a much lower cost of maintenance.

I believe producer gas can be made, washed, cooled and stored, if desired, and still the fuel economy of producer gas firing will compare favorably with our present methods, making no allowance for saving in labor saving, in life of settings, saving by use of a fuel of lesser cost, and the saving resulting from residuals of the producer gas furnace.

I do not think the radiation and other losses of the producer would exceed the present losses of heat in our waste products of combustion which cannot now be advantageously recovered, but which could be very readily recovered to a large degree if producer gas firing were adopted. It is very doubtful if any great fuel economy results from pre-heating our primary air, as we must keep the temperature in our furnace below the fusing temperature of the ash, and if we heat our primary air we must add enough more water to bring the temperature of the furnace down to the desired point. I will, therefore, confine my comparisons to those benches where only the secondary air is pre-heated, leaving the relative merits of full-depth and half-depth benches to be fought out by others.

If we assume that our gases have a temperatue of 2,500° F. at the entrance of the recuperator flues, and that ⅓ of all our coke must be gasified with water to keep the temperature of our fuel bed below the fusing point of ash, then we may safely take the following figures as a fair indication of the waste in our flue gases:

5 pounds C burned with 57.75 pounds air to (44.44 N)
18.33 pounds CO_2 = 5 pounds × 14,544 B. T. U. = ... 72,720 B. T. U.
1 pound C burned with 1.50 pounds water to (.166 H)
2.33 pounds CO = 1 pound × 4,400 B. T. U. 4,400
2⅓ pounds CO burned with 5.77 pounds air to (4.44 N) 3.66
pounds CO_2 = 2⅓ + 4,348 B. T. U. = ... 10,141

Total heat of combustion ..... 87,261 B. T. U.

Losses.

1.5 pounds H_2O from 60° to 212° F. 228
1.5 pounds H_2O latent heat at 965.7 B. T. U. per pound.. 1,448
1.5 pounds H_2O entering flues at 2,500° F. = 1.5 pounds × .48 sp. h. × (2,500°—212°) = ... 1,647
22 pounds CO_2 entering flues at 2,500° F. = 22 × .2164 sp. h. × (2,500°—60°) = ... 11,616
48.88 N entering flues at 2,500° F. = 48.88 H × .244 sp. h. × (2,500°—60°) = ... 29,101
4.44 N entering flues at 2,500° F. = 4.44 N × .244 sp. h. × (2,500°—60°) = ... 2,645
Total loss 46,685

Recovered by absorption in secondary air, which would be ⅓ of 57.75 pounds air = 28.87 pounds to burn 5 pounds carbon to CO_2 and
5.77 pounds to burn 2⅓ CO to CO_2 and
5.77 pounds to burn .166 pounds H to H_2O,

making in all 40.41 pounds.

Total heat absorbed = 40.41 pounds × .2379 sp. h. × (2,500°—60°) = 23,457
Net loss 23,228

Efficiency { Left for useful work, 64,033
Total heat developed, 87,261 73.4 per cent.

This would give the flue gases a specific heat of .2405 and the temperature of the escaping gases would be 1,124°+60° 1,184° F. This temperature is 200° F. in excess of our observed temperature at Denver on some recent tests we have been making on our benches, but our observations were so unsatisfactory that we did not place much reliance upon them. If temperature of the furnace is 2,500° F., as we believe it is, there is some error affecting our flue gas observations which we have not yet located. This apparent difference would be lessened, however, were we to correct for a slight excess of secondary air which we admit and also correct for the higher specific heat of the moisture contained with the air taken in for secondary combustion. Before completing our experimental work at Denver, we will obtain an agreement between the observed and calculated temperature.

Now, let us trace through the losses of producer gas firing. I think we can safely assume that temperature of outgoing gases will not exceed 960° F., when properly operated.

3 pounds C burned with 17.32 pounds air to (13.32 N) 7
pounds CO = 3 pounds × 4,400 H. of C = ... 13,200 B.T.U.
1 pound C burned with 1.50 pounds H_2O to (.166 pounds H) 2⅓ pounds CO = 1 × 4,400 H of C = ... 4,400

Total heat production 17,600

Losses.

9.33 pounds CO leaving producer at 960° F. = 9.33 pounds × .248 sp. h. × (960°—60°) = ... 2,082
13.32 N leaving producer at 960° F. = 13.32 pounds × .244 sp. h. × (960°—60°) = ... 2,925
.166 H leaving producer at 960° F. = .166 pounds × 3.4 sp. h. × (960°—60°) = ... 507
1.5 pounds H_2O dissociated = 1.50 pounds × 6,900 H. of D.. 10,350
1.5 pounds H_2O raised from 60°—212° = 1.50 pounds × (212°—60°) 228
Losses at producer outlet 16,092

Leaving for radiation and other losses 1,508

We now have 9.33 pounds CO yielding 9.33 pounds × 4,348 H. of C. = ... 40,566 B.T.U.
.166 pounds H. yielding .166 pounds × 53,410 H. of C. = 8,866 "

Total value ..... 49,432 "

4 pounds carbon used = 4 pounds + 14,544 H. of C = 58,176 B.T.U.
Left for useful work ..... 49,432 "

Loss in producer and sensible heat ..... 8,744 "

$$\text{Efficiency} \frac{49,432}{58,176} = 84.1 \text{ per cent.}$$

I do not think this efficiency is at all beyond what we can obtain in everyday practice. In burning this gas in the bench we will pre-heat both the incoming gas and the incoming air by the waste products of combustion. In the calculation made on our present methods I allowed no loss in transmitting the heat through the walls of the recuperator flues, but in this case I will assume an efficiency of approximately 84 per cent., and admit that we may have to use supplemental iron recuperator flues to get that.

9.33 pounds CO burned with 23.09 pounds air to (17.76 pounds N) 14.66 pounds CO_2 = 9.33 pounds × 4,348 H. of C. = ... 40,566 B.T.U.
.166 H burned with 5.76 pounds air to (4.44 N) 1.50 H_2O = 1.50 × 53,410 H. of C. = ... 8,866

Total heat of combustion 49,432

Losses.

N from producer = 13.32 pounds.
N added at furnace = 17.76 pounds.

N total,	31.08 lbs. × .244 sp. h. × (2,500°—60°) =	18,958 B.T.U.
CO	14.66 lbs. × .2165 sp. h. × (2,500°—60°) =	7,740
H_2O	1.50 lbs. × .48 sp. h. × (2,500°—60°) =	1,767
	Total loss.....	28,465

Recovered by absorption in ingoing gas and air.

CO 9.33 pounds × .248	sp. h. × (2,160°—60°) = ...	4,859
N 13.32 pounds × .244	sp. h. × (2,160°—60°) = ...	6,825
H .166 pounds × 3.4	sp. h. × (2,160°—60°) = ...	1,183
Air 28.85 pounds × .2379	sp. h. × (2,160°—60°) = ...	14,343
	Total recovery.....	27,210
	Net loss.....	1,255 B.T.U.

4 pounds carbon heating value		58,176
Loss in producer.....	8,744	
Loss in furnace.....	1,255	
Total loss.....		9,999
Left for useful work		48,177

$$\text{Efficiency} = \frac{48,177}{58,176} = 82.8 \text{ per cent.}$$

I know these figures will prove somewhat startling to some of my friends who are ante-producer men, and even after assassinating my estimates and substituting their own they will not be able to bring the results to the low value they now have in their minds. Here is a simple explanation which will perhaps appeal to all.

Neglecting the water used in our furnaces, 11.54 pounds of air are required to burn 1 pound of carbon; 5.77 pounds of this is primary air; 5.77 pounds of this is secondary air. We heat the secondary air only, or we heat but 50 per cent. of the air (by weight) and this 50 per cent. of air is but 46.01 per cent. of the flue gases. The specific heat of flue gas of this composition would be .238, while the specific heat of air is .2379, and the secondary air has thermal capacity for only 45.9 per cent. of the heat contained in the gases.

Taking the two conditions I have assumed in my comparison, between our present method of firing and firing with producers, the secondary air in the first example is 48.1 per cent. of the products of combustion, and has capacity for 47.6 per cent. of the heat contained in the gases. Taking the conditions I have assumed for producer gas firing the ingoing gas and air are equal in weight to the outgoing gas, and have a higher specific heat. Their thermal value is .2502 against .2467.

I append a tabulation of assumptions to enable anyone desiring to do so to check my computations on the data I used. The foregoing figures are only intended to be approximately accurate.

ASSUMPTIONS.

Specific Heat.

Air	.2379
O	.2182
N	.2440
H_2O—as water	1.
H_2O—as vapor	.48
H	3.4
CO_2	.2164
CO	.248
C	.20

Heat of Combustion.

C to CO	4,400
C to CO_2	14,544
CO to CO_2	4,348
H to H_2O (W)	62,100
H to H_2O (V)	53,410

1 pound H_2OW = in dissociating abs 62,100 ÷ 9 = 6,900 B. T. U.
1 pound H_2OV = " " " 53,410 ÷ 9 = 5,934 "
12.54 pounds flue gas consisting of 2.66 pounds CO_2 9.88 lbs. N.
8-9 pound O burning to CO = 8-9 × ($\frac{4}{3}$ × 8-9) × 4,400 = 2,933 B. T. U.
1 pound H_2O (water) to 1-9 pound H + $\frac{8}{9}$ pound CO abs. 3,969 "
1 pound H_2O (vapor) to 1-9 pound H + $\frac{8}{9}$ pound CO " 3,001 "
5.77 pounds of air required for secondary combustion.
5.77 " " " primary "
11.54 pounds total air required for combustion.
Making with 1 pound C. 12.54 pound flue gases consisting of 2.66 pounds CO_2 and 9.88 pounds N.

Thermal Capacity.

2.66 pounds CO_2 × .2164 = .5756
9.88 pounds N × .244 = 2.41
12.54 pounds 2.9856

Average specific heat .238
Thermal capacity of 5.77 pounds air at .2379 = 1.372683
1.372683 ÷ 29,856 = 45.9 per cent.
Air flue gas
5.77 ÷ 12.54 = 46.01 per cent.
Air gas

Air consists of 23 parts O by weight, and 77 parts N by weight. Each 100 parts of O must then carry 3.33 parts of N. Assume producer gas is discharged at 960° F.

Sp. H.—Specific heat.
H. of C.—Heat of combustion.
H. of D.—Heat of dissociation.

[To be Continued.]

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, April 10th, 1902.

The New Policy of the Welsbach Company.—A Debate on the Best Quality of Gas to Supply.—Gas Cookers Cheap and Good.

A notification has been issued by Mr. K. H. Buchanan, the General Manager of the Welsbach Incandescent Gas Light Company, to the effect that on and after July 1st a reduction will be made in the prices of Welsbach burners and mantles, and also that the terms of business will be revised so as to offer every facility with a view to the development and extension of the trade in these commodities. It is also stated that the revised policy has for its object relations of an increasingly intricate and cordial nature with the gas and allied trades. In addition to the withdrawal of various restrictions which have hitherto prevented the expansion of the business, the Company believes that the new prices and terms will constitute a strong inducement to accord to the Company a very largely increased support. They have decided to close their retail branches, but to establish wholesale depots in Manchester, Birmingham and Glasgow at once, and to follow with others as occasion may require.

Having on previous occasions devoted a good deal of space to the operations and methods of business adopted by this Company, it is with great satisfaction that I observe the recognition of two important points that have been labored strongly in my previous remarks. The first of these is an appreciation of the possible magnitude in store for an intelligently worked incandescent business. Of this there can be no question. With 5,000,000 private consumers in the United Kingdom, who at a very moderate estimate would average 2 burners and about 2 dozen mantles per head per annum, and with 3,000,000 public lamps, the whole of which are available for business, it is evident that the large totals which were produced with some pride by the previous directorate of the Company can be exceeded some 10, 15, or even 20 fold. The second point is a frank recognition of the fact that the policy hitherto followed has not been conducive towards such results, or calculated to give satisfaction to the public or the various traders concerned. A policy of protection is not a popular one, and those who hesitate before launching out on the lines of a fair field and no favor are looked upon with a certain amount of distrust. There is a very great irritation against anything that savors of monopoly, and therefore in removing restrictions the Company will find that they encourage the confidence of the public by expressing a confidence in the capability of their specialities to stand alone. At the present juncture, however, it would be ungracious to dwell too long on this aspect of the question, and I would rather turn to the prospects of more prosperous times for the Welsbach Company. Most gas companies are prepared and many of them are already in a position to undertake maintenance of mantles and burners, and no doubt it is this fact that the Company have in view in referring to the possibility of more intimate relations with gas companies. With the support that the Welsbach Company are able and are now willing to afford, there will be a rapid development in the use of incandescent burners just as there was in the case of gas cookers when the cookery demonstration class was introduced together with system of letting on hire. By comparing the state of the gas cooker trade to-day with its position 30 years ago it is possible to form some idea of the future before the incandescent mantle. Formerly the gas cookers in use averaged less than one to two consumers. Now it is a poor district that cannot boast a proportion of more than one to three. I have before observed that more credit is due to the stove manufacturers than to the gas companies for this happy state of things, and the Welsbach Company have it in their power, even to a greater extent than the gas company, to control the future of the incandescent mantle and burner.

Mr. Geo. Livesey has taken an opportunity of making a public statement on this subject. At the meeting of the Commercial Gas Company, in acknowledging his re-election as a director, he said that 2 months ago the Commercial Company had joined in promoting a fund for the defence of any actions that might be entered by the Welsbach Company against infringers of the patents. This fund has been placed at the disposal of a small company who were manufacturing mantles and who were not in a position to secure an adequate defence. A body of evi-

dence has been collected, but he thought that it would not be required; for the Advisory Committee of the Welsbach Company had asked him to meet them and give some information in connection with the use of incandescent mantles by gas companies. They had treated him in the kindest manner, and he informed them of the starting of the fund. They did not take it in a hostile spirit, but proposed an interview, which took place, and at which it was evident that they were prepared to deal in the fairest possible way with regard to the supply of mantles to gas companies. The negotiations were not completed and he was not in a position to state the exact nature of the proposals, but might say that the agreement would be on the basis of a small royalty of not more than a fraction of a penny per mantle. So he might say that the consummation they had hoped for, that incandescent mantle users in England would soon be placed on an equal footing with users in Germany in regard to getting good, cheap mantles, was not far short of attainment.

Meanwhile there is continual evidence of the demand for a cheaper and lower quality of gas as judged by the photometer, and a growing recognition of the importance of the calorimeter as an indicator of the practical value of the article. At a recent meeting of gas managers in Scotland, the home of cannel coal and of high candle gas, this fact was recognized in a marked manner. The President, in his opening remarks, said that at the last year's meeting an all but unanimous opinion was expressed that the consumers required and should be supplied with a a reduced quality of gas suitable for fuel purposes and incandescent lighting, and that it would be as effective for flat flame lighting. At all the meetings of gas managers throughout the year this opinion had been held with hardly a dissentient voice. So long as rich coal could be obtained it was natural that correspondingly rich gas should be made. But the supply of this kind of coal was gradually decreasing, and the price tended to rise, although checked by the competition of benzo', shale oil, petroleum and other enriching material. But a sufficient supply could not be maintained and this alone necessitated reduction of illuminating power. When this was done there would be a sufficient supply of coal to meet demands for a long time to come. A good heating gas at a low price was best able to supply all present wants, and it could hardly be gainsaid that not only the health and comfort of our cities, but the commercial supremacy of the country were, even more than in the past, dependent on a cheap supply of gas and a quality suited to meet the many demands of the future. Another view of the question was the difficulty of completely consuming rich gases and the consequent complaints of smoky ceilings, etc. He had been using benzol as an enriching material and found it highly satisfactory, and this experience was supported by several subsequent speakers. Mr. T. Wilson had saved 4¼d. per 1,000 cubic feet of gas by using benzol instead of shale. Mr. M'Lusky claimed that high quality gas was more suitable for distribution than low quality, but insisted that care should be taken to get suitable burners used. Mr. A. Wilson thought the line to follow was the recommendation of incandescent burners, and that all this enriching business was so much labor and so much money wasted. The illuminating power might be lowered without a corresponding loss of calorific value and the heating power would be the greatest factor in the future. He believed that unenriched gas from ordinary coal would prove the best for all parties. Mr. McGilchrist contended that it was their duty to supply the gas that gave the best value. Mr. D. Vass remarked that if everyone went in for oil and benzol there would not be enough to go round. Last winter he found difficulty in obtaining supplies. Mr. J. Ballantine said that lower quality gas would come and that the public would gradually be educated to it. In England the quality was being reduced by one candle at a time. Fittings would require to be allowed and he would not care to be in the shoes of the man who made a great drop, say from 24 to 16 candles at a stroke. Only a few years ago he advocated a maximum of 24-candle gas in a discussion when many were advocating 28 to 30-candle, so he was interested to hear such a decided change of opinion. Mr. J. Kincaid said that 15 to 20 years would see 8 or 10-candle gas not only in England but in Scotland, and there was far more in the manner in which the gas was consumed than in the photometrical quality of it. He advocated undertaking the maintenance of mantles and burners. Mr. A. Wilson agreed in giving the consumers the best value, and thought that more might be done in this direction by following the suggestion of the last speaker than by adopting enrichment processes.

The trend of all these remarks is to illustrate the importance of taking up calorimetry at the gas works. Most gas managers test the photometrical value regularly, but how many are equally acquainted with the heating value? How many know within 10 per cent. the capabilities in this respect of the article they supply. The calorimeter must be at once installed in the testing room, and regularly used. And when we talk of instructing the consumer in the matter of waste of light through the use of unsuitable burners, is there no such thing as a corresponding waste of heat? I think it will be found that there is room for a large economy in respect to the use of gas for heating purposes. There has been a great improvement in this respect, but when we come to test one heating burner against another, as we do lighting burners, it will be found that there is room for further advance. One hint may be given for the use of intending investigators in the hitherto unexplored region of heating values, and that is with regard to the accuracy of the instruments used. The calorimeter involves the accurate reading of temperatures to within a tenth of a degree, and the accurate reading of the test meter index to within the smallest unit division on the dial. Only those who have actually carried out delicate scientific research can appreciate the difficulties concerned in arriving at a high degree of refinement as regards the accuracy of the meters and of the thermometers, and if the results are to be used on data for calculation or comparison care must be taken that the readings are reliable.

The demand for a cheap but serviceable cooker in connection with the slot meter system has led to very active competition on the part of makers, and it is possible to obtain remarkably low quotations for lots of a dozen or upwards. Nor is this a case of cheapness at the expense of quality, but the articles are of such design and finish as to leave no room for hesitation in recommending or adopting them. A cooker with oven of decent size, say, 14 by 12 by 18 inches, with griller, a boiling burner, a simmering burner and all necessary accessories is offered for about £1 10s., and is really a very decent article, reflecting great credit on the enterprise and ability of the makers. In most districts such stoves will readily command a rental of 2s. per quarter, so that the cost of stove and fixing is covered in five years, and the hiring business assumes a different complexion to that of some years ago when a stove cost £5 or £6. Now £100 invested in 50 stoves means on the lowest basis a sale of 500 to 600,000 cubic feet of gas per annum. The profit on that quantity at 1s. per 1,000 cubic feet is about £30, so that gas companies who hesitate about developing the cooking trade must indeed be regarded as being limp either on account of natural laziness or of nervous incompetency. Another modern notion is a serviceable and elegantly designed, self-contained household boiler, of 10 to 20-gallon capacity for laundry and general domestic purposes. The pan is surrounded by an outer casing with flue, and there is also an arrangement for conducting the steam from the boiling water into the flue. This of itself robs washing day of half its terrors. The price at which the boiler is offered is so low that even the most modest pocket can be accommodated by supplying it on a short period hire purchase system.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. F. H. CORSON has been appointed Superintendent of the Winnepesaukee Gas and Electric Company, of Laconia, N. H. Mr. Carson was a resident of Concord, N. H.

WHILE no one who was in any sense posted over the rumor put the slightest faith in it, the following denial of the same by a prominent Director in the United Gas Improvement Company is worth reading: "The story that the United Gas Improvement Company contemplates entering the New York field, either through acquiring the Consolidated Gas Company, or undertaking a competition with that Company, is absurd. Our relations are entirely amicable with the Consolidated Company, and we have no reason or intention to enter that particular field." Likely it is just as well.

AT the annual meeting of the shareholders in the Bangor (Pa.) Gas Company the following officers were elected: Directors, A. M. Paff, Herbert Slamp, W. R. Grubb, John Langmead, C. N. Miller, Emanuel Schoch and Wm. H. Correll; President, A. M. Paff; Secretary, Clarence Beck; Treasurer, Oliver Le Bar; General Superintendent, W. H. Miller.

BY virtue of a notice recently filed it is announced that the capital stock of the Fox River Valley (Wis.) Gas and Electric Company has been increased to $400,000.

MR. D. R. RUSSELL and his wife sailed for Europe, per steamship Deutschland, on the 17th inst. They expect to return home before August 1st.

THE Superintendents of the gas plants controlled by the syndicate, of which Mr. W. T. Morris is head, held a very interesting convention on the 17th and 18th days of this month. Headquarters were in the Clinton House, Ithaca, N.Y., and the meeting was a success in every particular.

THE Wausau (Wis.) Gas Company is successfully conducting a series of demonstration lectures on the advantages of cooking by gas. The lecturess is Miss Ora A. Blanchard, of the Milwaukee Cooking School.

THE gas supply of Petaluma, Cal., will hereafter be obtained from the mains of the Company at Santa Rosa, Cal. Beginning with the 1st prox., the rate for fuel gas in Petaluma will be placed at the extremely liberal figure of $1.50 per 1,000 cubic feet.

ACTIVE construction work on the gas plant for the Boonton (N. J.) Gas and Improvement Company has been commenced. It is said that the gas will be laid on to the town by September 1st.

MR. ROBERT M. BURNETT, Receiver for the New England Gas and Coke Company, under an order by Judge Colt, in the United States Circuit Court, Boston district, is issuing Receiver's certificates in the sum of $285,000. The main amounts owing that are of urgent necessity for payment are something over $200,000 due the Dominion Coal Company and 2 years back taxes to the city of Everett.

THE Eastern offices of the Western Gas Construction Company, on and after May 1st, will be located in room 2017, Park Row Building, New York.

THE properties of the Evansville (Ind.) Gas and Electric Light Company have been nominally acquired by the brokerage concern of Farson, Leach & Co., Chicago. The names of the actual purchasers have not been revealed.

AT the annual meeting of the Bordentown (N. J.) Gas Light Company the following Directors were elected: John P. Hutchinson, J. H. Longstreet, John J. Kuser, R. H. Aaronson and Jno. M. Hutchinson.

THE proprietors of the Dayton (O.) Gas Light and Coke Company have accepted the terms of the ordinance passed by the authorities under which it is stipulated that the gross selling rate is to be $1 per 1,000 cubic feet, with 15 cents off for prompt payment. Gas at 85 cents per 1,000 looks like a liberal proposition for Dayton.

AT the annual meeting of the Chuctanunda Gas Light Company, Amsterdam, N. Y , no change was made in the executive management. A semi-annual dividend of 3 per cent. was declared. The work on the rehabilitation of the purifying house is proceeding satisfactorily.

THE proprietors of the New Bedford (Mass.) Gas and Edison Light Company have awarded a contract to the Western Gas Construction Company, of Fort Wayne, Ind., for the construction of an exhausting, tar extracting, condensing, scrubbing and washing apparatus, up to handling an output of 750,000 cubic feet per diem. The Western Company's type of condensing plant is to be installed.

THE Louisville (Ky.) Gas Company recently issued the following notice, the importance of which will be readily understood when it is remembered that there is in Louisville a Company which supplies gas for heating purposes *only*: "By order of the Board of Directors of the Louisville Gas Company, the following regulation in reference to connections made and to be made by this Company is hereby adopted: Gas to be furnished by this Company must not be turned off or on, except by one of its employees. Persons using the gas of this Company are not permitted to do so through pipes which are at the same time connected with the supply of another Company. This resolution is adopted because such dual connection and power to a consumer to turn off and on the gas of this Company, at pleasure, is liable to subject both him and other consumers to injury and loss."

THE authorities of Richmond, Va., are still haggling over the proposition to construct a gasholder for the better supply of gas from the city gas works to the district known as the West End. It has been shown that to ensure a good supply over the district a holder up to retaining 2,000,000 cubic feet should be erected, and at once. In fact, if some sort of relief is not granted, Superintendent Knowles will not be able to half fairly administer to the demands of the West Enders for gas this winter.

AT the annual meeting of the Lambertville (N. J.) Gas Light Company, no change was made in the executive management. Superintendent Gandey's reports showed a good increase in output for the twelvemonth.

MR. A. H. BRANCH, who was for quite a while the active man in the Denver (Col) Gas Company, has been elected President of the Oklahoma City Gas and Electric Company, which concern resulted from the consolidation of the rival interests that proposed to light from central stations the largest city in Oklahoma territory. May Mr. Branch have the best of good luck in his new venture.

MR. WILLIAM DURBIN COUCH, who had for many years efficiently and successfully acted as Treasurer of the Altoona (Pa.) Gas Company, died at his home in Altoona, the afternoon of the 12th inst. "T. J. M.," the correspondent who forwarded us this information (he wrote under date of the 21st inst.) thought that the fact of Mr. Couch's death should be noticed, in that deceased had been well known to the fraternity of Western Pennsylvania. Deceased was in his 57th year, having been born in Huntingdon, Pa., September 15, 1845.

THERE is little doubt that parties prominent in the direction of the United Gas Improvement Company have been mainly concerned in the negotiations for the control of the gas, electric and street railway properties of Providence and Pawtucket, R. I.

THE Board of Gas and Electric Light Commissioners has assented to the increase in capital petitioned for by the proprietors of the Lowell (Mass.) Gas Light Company.

THE Peninsula Gas Company, through M. N. Sheldon, has withdrawn its application for the right to construct and operate a gas works in Palo Alto, Cal.

A CORRESPONDENT, writing from Bridgeport, Conn., under date of the 19th inst., incloses the following: "At the annual meeting of the shareholders in the Bridgeport Gas Light Company the Directors chosen were: I. De Ver Warner, W. D. Bishop, W. B. Hincks, Goodwin Stoddard, A. N. Brady, C. F. Dieterich, A. B. Proal, A E. Dieterich and C. H. Mead. The Directors elected the following officers: President, I. De Ver Warner; Secretary and Treasurer, F. B. Sammis; Superintendent, C. F. Gerdenier. It was voted to extend the mains to Fairfield and Southport, and the work thereon will be undertaken at once. It is thought that the changing over of the fuel gas plant formerly operated by the Citizens Gas Company, to an illuminating gas plant, will enable the Company to serve Fairfield and Southport without additional plant construction. The making of fuel gas will be discontinued within 2 or 3 weeks. The employees of the Company have been changing the heating and cooking apparatus of consumers on the lines of the Citizens Fuel Gas Company to adapt the same to the product sent out by the old Bridgeport Company, and it is thought such changes will all have been completed by May 15th. The business of the Bridgeport Company is increasing in wonderful degree, and there is not a more stable financial concern in this State of many industries."

THE authorities of Batavia, N. Y., have granted an extension in the franchise privileges of the Batavia Consolidated Gas and Electric Company, the privileges to terminate 1940. New proprietors are now in control of the fortunes of this Company. The new executive management is as appended: President, Daniel Y. Lewis; Secretary, Richard C. Gerhart; Treasurer, Jno. Thomas. The Company has also put the selling rates on the following basis: Gross, per 1,000 cubic feet, $1.60 on illuminating account, with 12½ per cent. off for prompt payment within 15 days. The rate on fuel account is $1 per 1,000.

AT the annual meeting of the Rochester (N. Y.) Gas and Electric Company the following officers were chosen: Directors, Frederick Cook, Wm. Runkle, George W. Archer, Albert H. Harris, G. A. Hollister, W. J. Johnston, Geo. C. Hollister, H. L. Brewster, J. N. Beckley, George A. Redman, Wray L. Cole, C. B. Judson and J. R. Judson; President, Frederick Cook; First Vice-President, Chas Judson; Second Vice-President, Wm. Runkle; Treasurer, George W. Archer; Secretary and Assistant Treasurer, W. L. Cole; Attorney, A. H. Harris. The President announced that papers had been signed completing the sale of the Citizens Light and Power Company and of the Municipal Gas and Electric Company to the Rochester Gas and Electric Company. This transaction puts the last named concern in complete possession of the supply of gas and electric currents from central stations to the people of Rochester and the outlying districts.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

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OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.

Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co. 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, APRIL 28, 1902.

The Market for Gas Securities.

The past week was an eventful one in the trading in local gas shares. Consolidated sold above 231, and closed to-day (Friday) at 228 to 228¼. Some heavy transactions were recorded, the sales on Thursday amounting to 33,400 shares. Those in authority say there is no good reason to contemplate in the near future an amalgamation or merger with the Brooklyn Union Company, but those not in authority in effect claim that the deed is as good as done. The Directors of the Consolidated declared to-day the usual quarterly dividend of 2 per cent. It is payable the 15th prox. Mutual is 350 bid.

The real sensation of the week, however, was in Brooklyn Union. Closing last Friday at 224 to 225, it sold since above 242, the closing rate this afternoon being 239½ to 241. Whether consolidation is close at hand or not, and whether or not the Company will have to add largely to its manufacturing capacity this season, to meet the demands that will be made upon it by its customers, the Company's general position is such that 300 would not be an extravagant price for its shares. There are such things as surplus accounts in existence. A scanning of the general list shows decided improvement all round, save in the instance of Washington (D. C.) gas, which experienced a sharp decline from the skyward prices of a week ago. This decline in Washington gas is not in line with reason, for the causes which put it up early in the month (mainly regarding legislation to enable it to absorb the Georgetown Company, and to largely increase its capital stock) are seemingly closer to practical effect now than then. Good gas bonds are in great demand.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

APRIL 28.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	228	228¾
Central Union, Bonds, 5's.	3,000,000	1,000	109	110
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	..
Municipal Bonds	750,000	.	..	..
New Amsterdam Gas Co. ..				
Bonds, 5's	11,000,000	1,000	111⅛	..
Northern Union, Bonds, 5's.	1,250,000	1,000	106	108
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Richmond Co., S. I.	348,650	50	100	..
" Bonds	100,000	1,000	103	..
Standard	5,000,000	100	130	140
Preferred	5,000,000	100	150	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	117
Yonkers	299,650	500	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	239½	241
" " Bonds (5's)	15 000,000	1,000	119	119⅛
Bay State	50,000,000	50	1	1¼
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works...	450,000	100	28	30
" 1st Mtg. 5's	500,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	11	11½
" " Bonds, 5's	5,250,000	1,000	85	85½
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co..	29,500,000	100	102½	102¾
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	108	109
Columbus (O.) Gas Lt. & Heating Co	1,682,780	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	103
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore...	11,000,000	100	71	71¼
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	380,000	1,000	82	83
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	.	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	382,000	1,000	70	73
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	...	.	.
" Bonds	2,000,000	..	58	63
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	102	104
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	75	80
" Bonds, 6's	2 650,000	..	104¾	107
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	.	90
Preferred	2,500,000	100	..	110
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	57	62
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	109½
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	182	184¼
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	104⅝	104¾
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	48	48½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's.	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's.	2,465,000	1,000	92	93
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96½
Syracuse, N. Y.	1,750,000	100	15	17
Bonds	1,612,000	1,000	95½	97½
Washington, D. C	2,600,000	20	383¾	387½
First mortgage 6's	600,000	..	..	..
Western, Milwaukee.				
Bonds, 5's	4,000,000	..	109½	110
Wilmington, Del	600,000	50	232	..

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DIVIDEND NOTICE.

AMERICAN LIGHT AND TRACTION CO.,
JERSEY CITY, N. J., April 22, 1902.

The Board of Directors has this day declared a quarterly dividend of 1½ per cent., for the quarter ended March 31, 1902, on the preferred stock of the Company, payable May 15, 1902, to preferred stockholders of record at the close of business on April 30, 1902. The transfer books will not be closed for payment of said dividend. Checks will be mailed. EMERSON McMILLIN, President

Prompt notice of any change in address should be given to Emerson McMillin, Transfer Agent, 40 Wall street, New York; or The Michigan Trust Co., Transfer Agents, Grand Rapids, Mich. 1403-1

WANTED,

Position as Superintendent of Gas Plant,

By a man with several years' experience, both coal and water gas. Familiar with details connected with manufacturing, distribution and office work. Best of references. Town in the West preferred.

1400-5 Address, "H.," care this Journal.

WANTED,

Situation as Superintendent of Gas Works,

By a man of 35. Thoroughly familiar with coal and water gas. Twelve years' experience. Has had good success in increasing output and getting business. Can furnish good references. Thoroughly practical and familiar with all branches of the business. Address, "N. V. B."

1399-tf Care this Journal

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Position as Manager or Superintendent,

By an energetic man, having had a large experience in the manufacture and distribution of both coal and water gas. Fully competent to supervise all improvements and extensions. A1 references. Address, "W. J. V.,"

1401-3 Care this Journal.

GAS MAKER WANTED,

To operate a standard Lowe gas plant in a growing town, 6 miles from New York. Must be steady, and thoroughly understand the Lowe system. A permanent place for the right man. Address, "J. C.,"

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WANTED,

Second-Hand Apparatus, as follows:

4 Purifier Boxes, about 8 feet by 8 feet by 2½ feet.
1 Five-foot Station Meter.
1 Set Water Gas Apparatus, 4 feet or 4½ feet.

Send full specifications, plans and price, with date of delivery. Address,

"STANDARD,"

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Fifty-two (52) Street Lamp Posts,

Complete, and in good condition. Will be sold cheap. Also,

Iron Work for Bench of 3's,

Complete, and in good order. Address,

INDEPENDENCE GAS AND COKE COMPANY,
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Two Sets of Lowe Water Gas Apparatus,

Six feet in diameter; style known as Granger-Collins, single superheater setting, erected by the United Gas Improvement Company in 1887 and 1889. Both of these sets are complete and in good condition, and will be sold very cheap. Immediate delivery could be made. Address,

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1403-1 Atlantic City, N. J.

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Apparatus for Complete Water Gas Plant,

Consisting of 5-ft. cupolas; purifying boxes, with center seal; engine, boiler, blower and holder.

Address, "P. R. R.,"

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FOUR PURIFIERS, 10 feet by 10 feet, by 6 feet deep, with 24-inch seal. Oxide chutes, with self-sealing covers, dry center seal, 10-inch connections, supporting columns and I-beams, hydraulic lifts, track and transferring tackle. Ready to ship about May 21st.

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One 4-foot Lowe Water Gas Set,

With scrubber, condenser, engine, blower, boiler and pump; all in first-class condition.

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CHARLES THOMAS,
No. 97 Main Street,
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WE PURCHASE:

Gas properties,
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Street railway properties.
Also desirable franchises.

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Engineers of standing and acquaintance in Europe are desirous of securing the handling of some good inventions abroad. We want such as will justify the organization of companies. Liberal propositions for the right articles.

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GAS BURNERS,

To burn a given amount at a stated pressure, made to order. Samples furnished. Also, small oil and air valves, slow-feed valves for high pressure, and small brasswork in general.

Drip Pumps, Service Cleaners, Gasfitters' Proving Pumps and Mercury Gauges.

C. GEFRORER & SON,
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We make a specialty of SECOND POOL YOUGHIOGHENY GAS COAL.

The Queen City Coal Co., CINCINNATI, OHIO.

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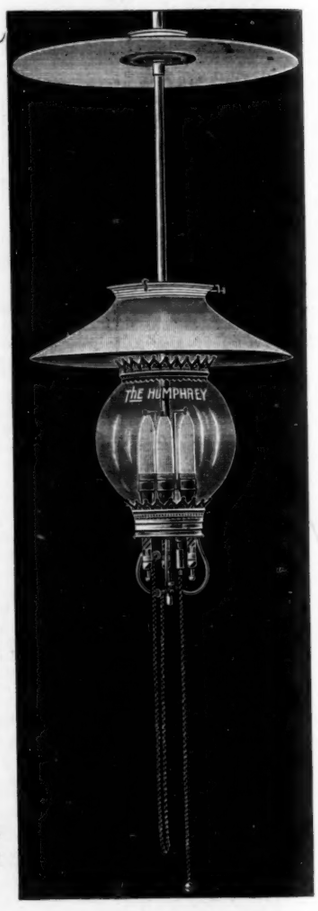

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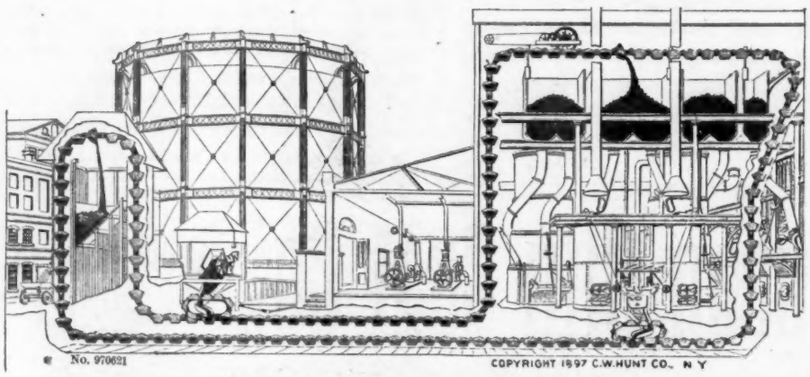

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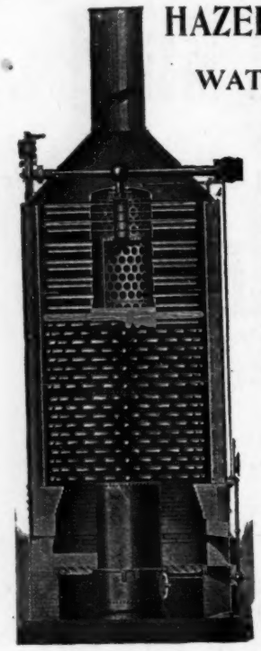

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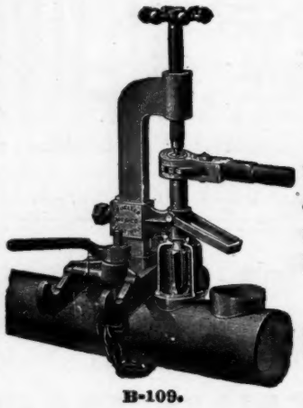

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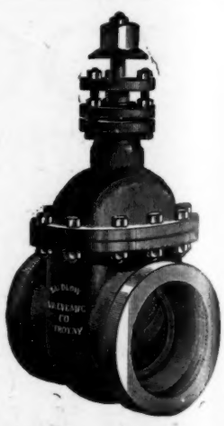

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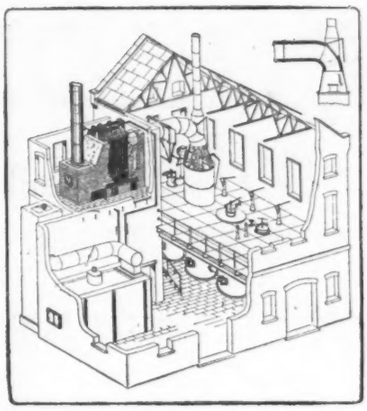

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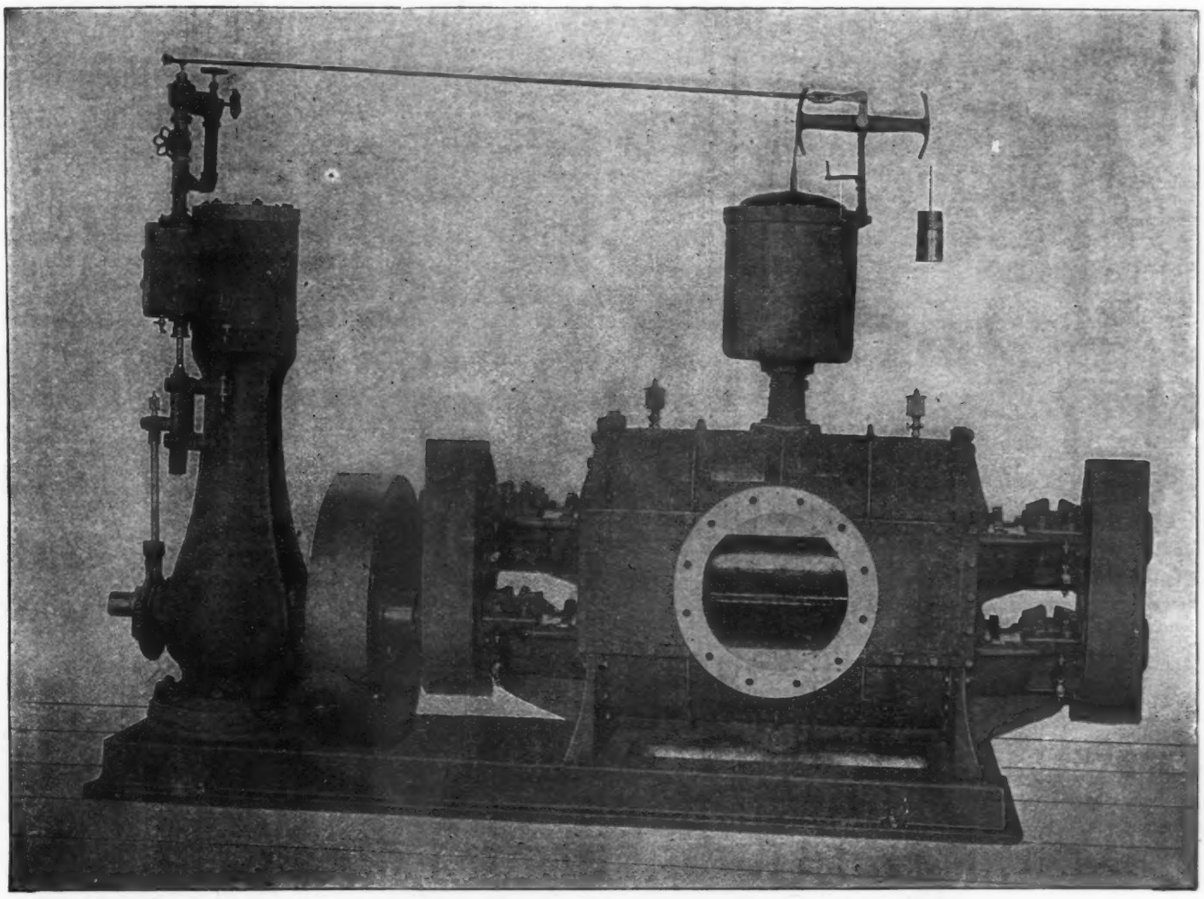

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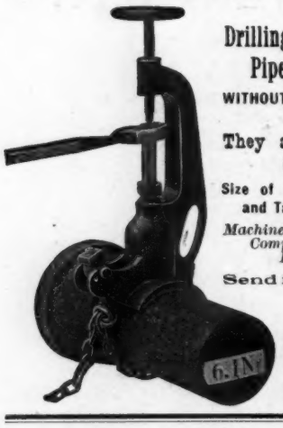

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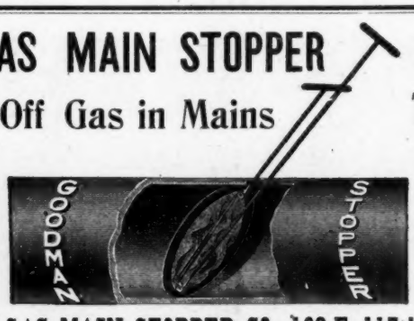

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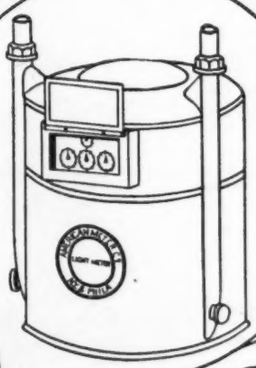

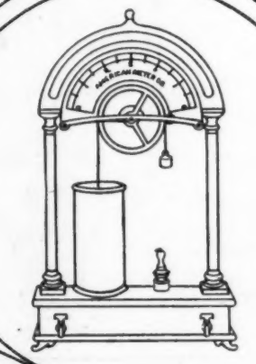

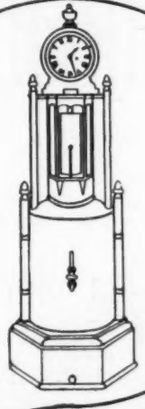

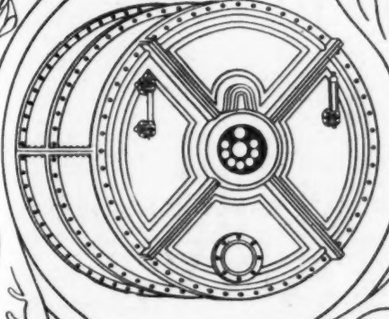

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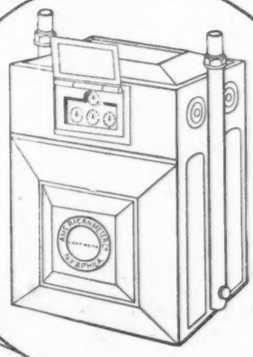
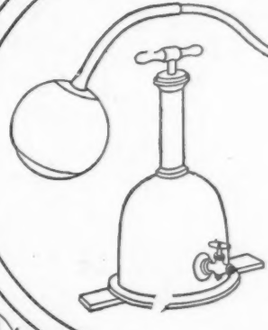
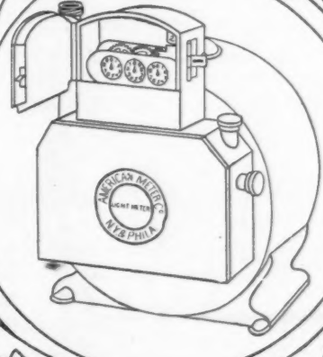






PUBLIC LIGHTING TABLE.

MAY, 1902.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Thu.	1	7.20 PM	2.40 AM	6.45	4.00
Fri.	2	7.20	3.10	6.45	4.00
Sat.	3	7.20	3.40	6.45	4.00
Sun.	4	7.30	3.50	6.45	4.00
Mon.	5	7.30	3.50	6.45	4.00
Tue.	6	7.30	3.50	6.45	4.00
Wed.	7	7.30 NM	3.50	6.55	3.40
Thu.	8	7.30	3.50	6.55	3.40
Fri.	9	7.30	3.50	6.55	3.40
Sat.	10	7.30	3.50	6.55	3.40
Sun.	11	7.30	3.50	6.55	3.40
Mon.	12	10.50	3.50	6.55	3.40
Tue.	13	11.30	3.50	6.55	3.40
Wed.	14	12.00 FQ	3.50	7.00	3.30
Thu.	15	12.30 AM	3.50	7.00	3.30
Fri.	16	1.00	3.50	7.00	3.30
Sat.	17	1.30	3.50	7.00	3.30
Sun.	18	2.10	3.40	7.00	3.30
Mon.	19	2.40	3.40	7.00	3.30
Tue.	20	No L.	No L.	7.00	3.30
Wed.	21	No L. FM	No L.	7.10	3.15
Thu.	22	No L.	No L.	7.10	3.15
Fri.	23	7.40 PM	9.20 PM	7.10	3.15
Sat.	24	7.40	10.10	7.10	3.15
Sun.	25	7.50	10.50	7.10	3.15
Mon.	26	7.50	11.30	7.10	3.15
Tue.	27	7.50	12.00	7.10	3.15
Wed.	28	7.50	12.40 AM	7.15	3.15
Thu.	29	7.50	1.10	7.15	3.15
Fri.	30	7.50 LQ	1.40	7.15	3.15
Sat.	31	7.50	2.10	7.15	3.15

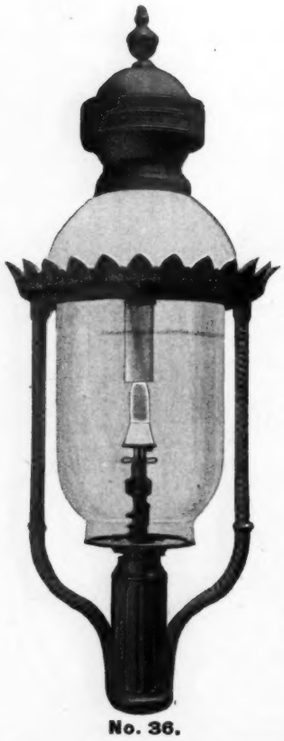
TOTAL HOURS LIGHTING DURING 1902.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	238.30	January	423.20
February	196.20	February	355.25
March	196.20	March	355.35
April	166.40	April	298.50
May	151.40	May	264.50
June	131.10	June	234.25
July	142.40	July	243.45
August	162.00	August	280.25
September	179.00	September	321.15
October	216.30	October	374.30
November	224.10	November	401.40
December	250.00	December	433.45
Total, yr.	2255.00	Total, yr.	3987.45

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



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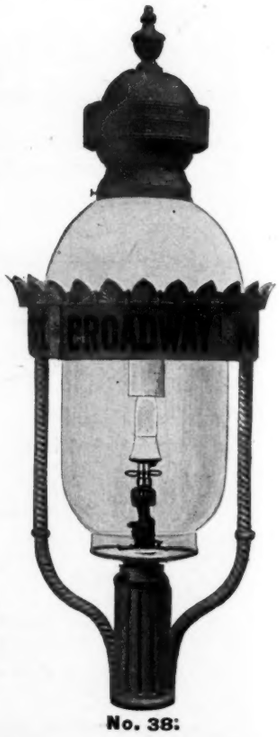

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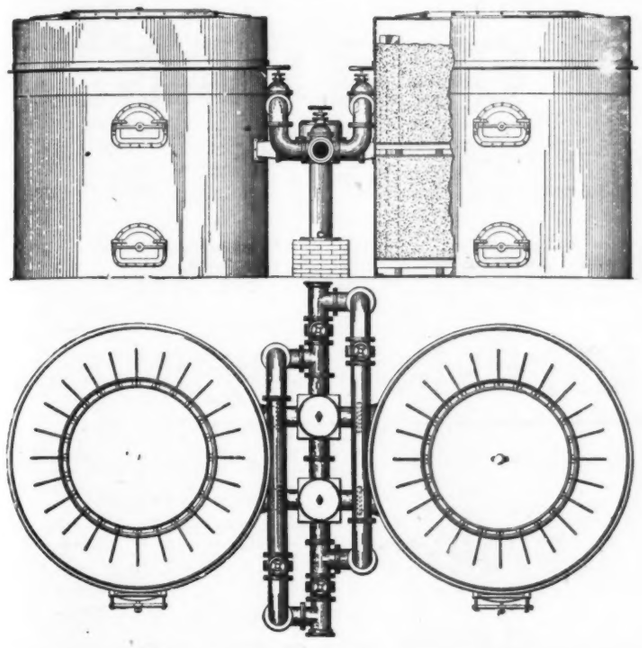

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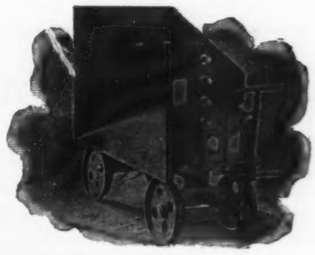

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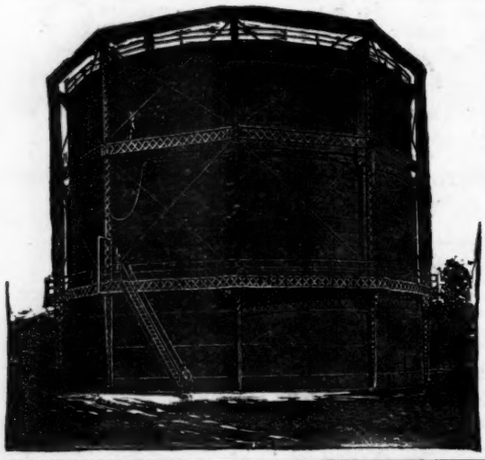

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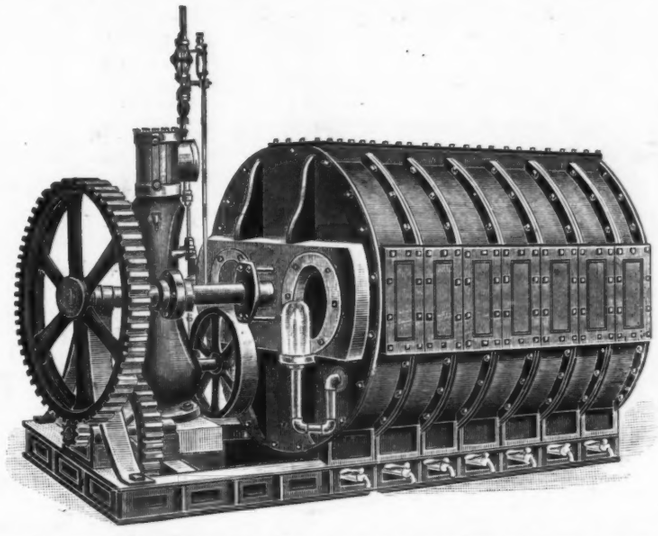

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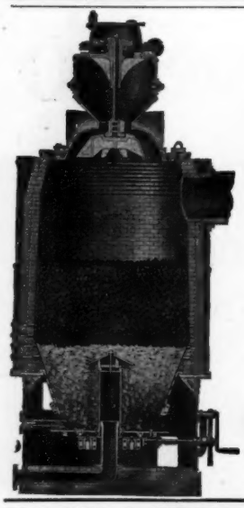

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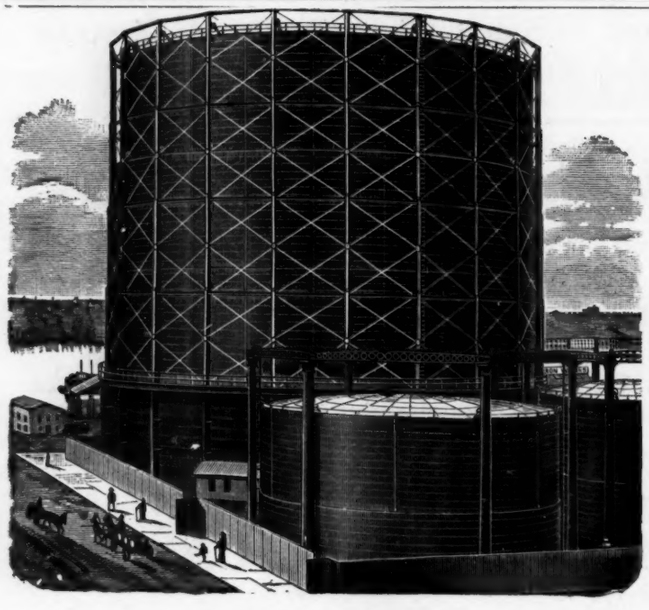

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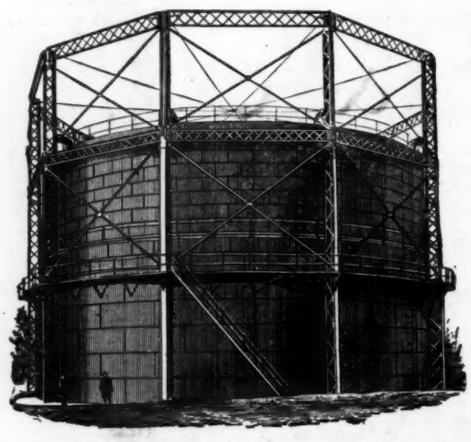

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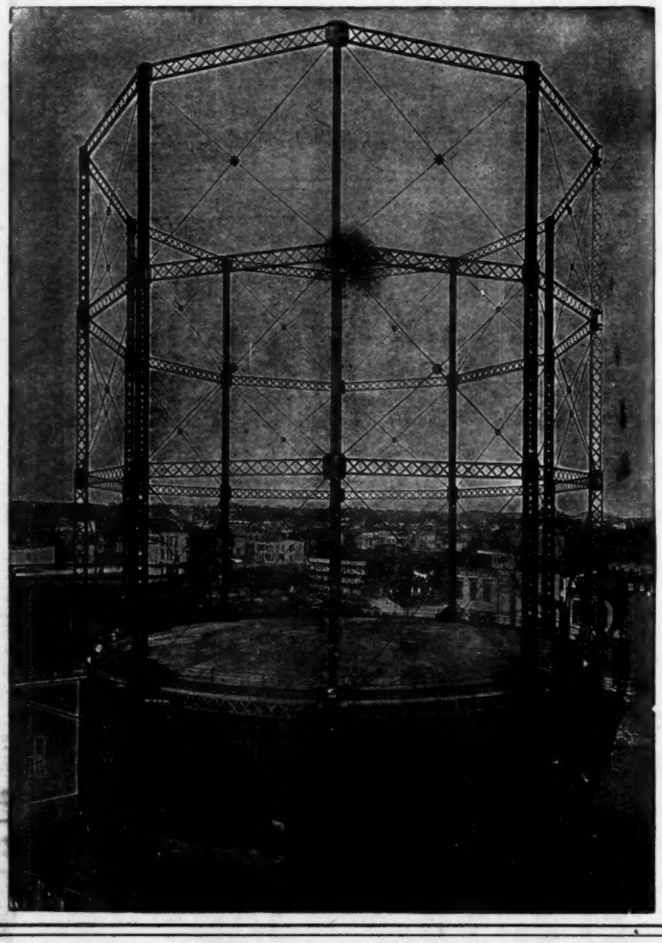

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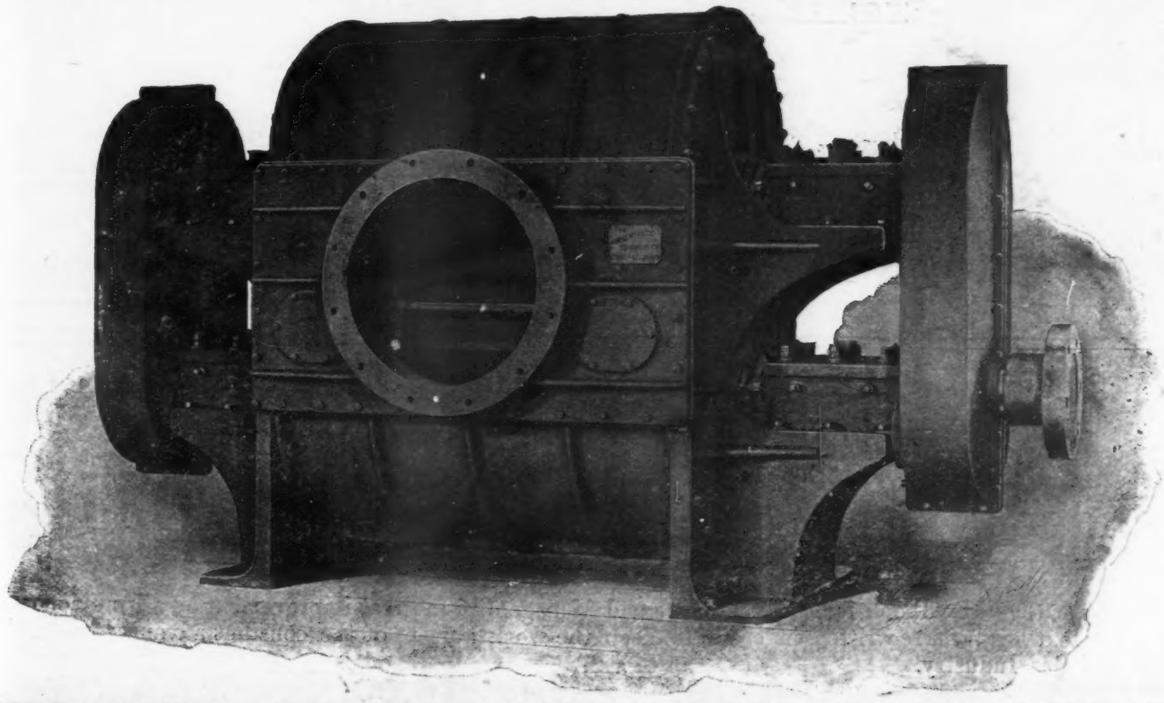

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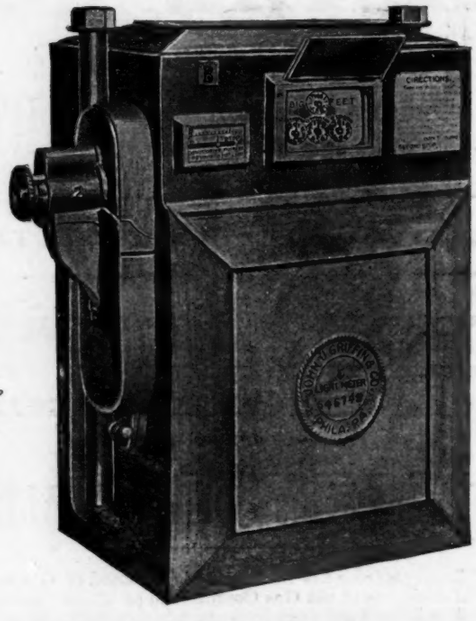

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